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ELECTRICAL REVIEW

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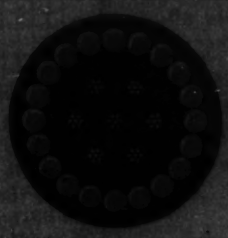

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THE TELEGRAPHIC JOURNAL AND

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VOL. XVII.—No. 422.

GAS ENGINE PATENTS.

THE result of the case of "Otto *v.* Steel" has probably put an end to the hopes, for the time being, of many inventive minds and enterprising manufacturers, who would fain have produced a gas engine that should be as good as that of Otto, without being precisely similar. Messrs. Green, of Leeds, thought they had constructed such an engine, upon the specification of Mr. Robert Steel, but they have now learnt otherwise from the lips of Mr. Justice Pearson, and there is nought for them but to submit—unless, indeed, they are so confident that there is an essential difference between their engines and the Otto that they are resolved to consult a yet higher tribunal. When the French courts declared a few months ago that the Lenoir engine was not an infringement of the Otto patents, and that Otto had been anticipated in several respects by Boulton, Beau de Rochas, and others, no doubt many of the English manufacturers thought, as we did, that there was a strong probability in favour of a similar result attending any litigation which might arise in this country. The fates, and Mr. Justice Pearson, however, have decided otherwise, and Otto has triumphed.

Defeated in regard to gas, inventors might now with advantage turn their attention to the development and perfection of the petroleum engine. And by this we do not mean an engine in which oil is burnt direct as fuel, but one in which oil is employed as in such prime motors as the Etéve engine, where a fine spray of the liquid is injected into the cylinder with air under slight pressure, the resultant mixture being highly explosive and easily ignited by means of a spark from an induction coil or by a flame, as in the Otto engines. We have ourselves seen during the last year two distinct types of motor working upon this principle, both of which are ready for commercial application, and the working cost of which would probably be but one-half that of gas. Of course, such engines can not only compete with steam and gas motors on their own ground, but they are also available where neither steam nor gas can be readily obtained, and where, indeed, both are absolutely unobtainable. It must not be thought that we are speaking of apparatus which is only in the experimental stage: one of the two engines to which we have above referred is constructed in types varying from 1 to 40 or 50 horse-power, and is capable of immediate practical application.

Incandescent Lamps.—We should like to know the opinions of our readers experienced in the manufacture of these lamps, respecting the remarks of Mr. Siemens on filaments which require but $2\frac{1}{4}$ to $2\frac{1}{2}$ watts per candle-power.

ON IMPROVEMENTS IN GLOW-LAMPS.

By WILHELM SIEMENS.

(*Continued from page* 516.)

THE experiments were made with prepared (on the new Siemens and Halske process) and unprepared filaments, and a specifically different behaviour of these two kinds of lamps was distinctly observed. It cannot, indeed, be maintained with certainty that the different behaviour of these lamps can be entirely referred to the difference in the carbon filaments. For though it would have been, strictly speaking, the most correct thing to make both kinds of lamps absolutely alike in all other respects, this idea had to be renounced in order to avoid other and perhaps greater sources of error. For the correct treatment of a new material can only be gradually found on the basis of prolonged and varied experience, and such experience was not at command with reference to the unprepared carbon filaments. It seemed, therefore, most suitable to use for this part of the experiments American Edison lamps, which have a filament of carbonised bamboo fibre of a rectangular section.

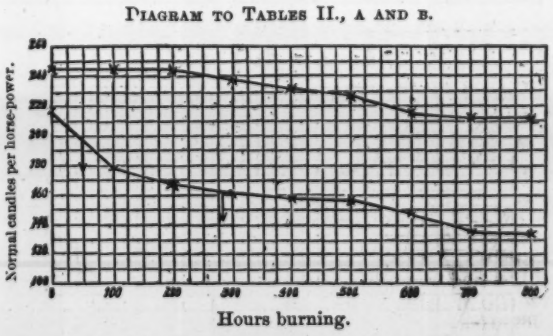
The measurements extended over a time of 800 hours, and were executed at intervals of 100 hours as regards strength of light, strength of current and tension.

Table II. contains measurements made on groups of 10 lamps respectively with prepared and unprepared filaments. The values given are the means of the measurements of each such group. The lamps burned during these experiments at their normal tension, at which they are supposed to give the light of 16 candles.

TABLE II. A.—LAMPS WITH UNPREPARED FILAMENTS.

Time of burning in hours.	Tension in volts.	Current in ampères.	Strength of light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	96	0·710	19·9	215	One lamp burst in 50 hours; 1 lamp burst in 280 hours; 1 burnt out in 650 hours; the remaining 7 still exist.
100	,,	0·674	15·7	178	
200	,,	0·656	14·3	167	
300	,,	0·654	13·8	160	
400	,,	0·650	13·2	155·5	
500	,,	0·636	19·9	155	
600	,,	0·632	12·2	148	
700	,,	0·630	11·1	135	
800	,,	0·630	11·0	134	

DIAGRAM TO TABLES II., A AND B.



Hence it appears that the greatest difference in the power of the light amounts to 8·9 candles, and that the lamps burned for the 800 hours with a mean value of 13·58 candles and a mean effect of 159·1 normal candles per electric horse-power. At the conclusion of the measurements the effect was only 62·3 per cent. of its original value; the strength of light had fallen to 55·3 per cent. of its initial amount, whilst the resistance (hot) had increased by 12·7 per cent.

B.—LAMPS WITH PREPARED FILAMENTS.

Time of burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	96	0·550	17·5	244	At the conclusion of the experiments all the 10 lamps were still in existence.
100	,,	0·550	17·5	244	
200	,,	0·550	17·5	244	
300	,,	0·544	17·0	239	
400	,,	0·544	16·5	232	
500	,,	0·540	15·9	225	
600	,,	0·535	15·05	215	
700	,,	0·528	14·5	213	
800	,,	0·528	14·5	213	

The greatest difference in the strength of the light is here three candles. The lamps burnt with a mean intensity of 16·24 normal candles and a mean useful effect of 230·1 normal candles per electric horse-power. The useful effect declined in the course of the 800 hours to 87·3 per cent., and the intensity of light to 82·9 per cent. of its initial value. The increase of resistance amounted to 4·2 per cent.

These results are illustrated by the curves in Diagram II. The hours of burning are taken as abscissæ, and as ordinates the number of normal candles produced by an electric horse-power. The upper curve shows the results with prepared, and the lower curve with unprepared filaments. The crosses on the lower curve mark the spot where a lamp has burst.

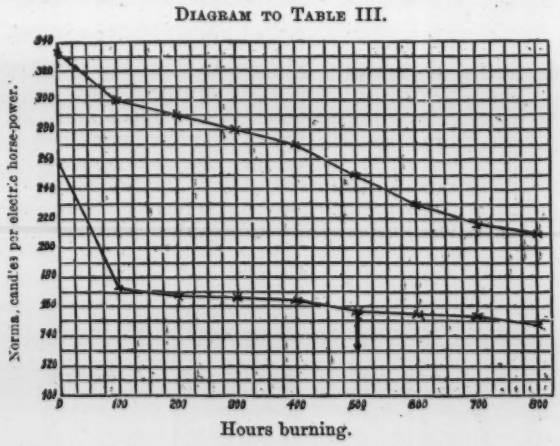
The form of the curves shows a characteristic difference in so far as with unprepared filaments the effect in the first portion of the time declined comparatively rapidly, whilst at the same point the prepared carbons were far more constant.

It was now important to examine how the two kinds of lamps would behave if the experiments were made with a higher initial effect. Ten of each kind were again set in action, all the 20 being supplied by one common circuit. In the following Table III. the mean values are given.

TABLE III. A.—LAMPS WITH UNPREPARED FILAMENTS.

Time of burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	100	0·687	24·25	259	After 15 hours 1 lamp burnt out; the remaining 9 were still in existence at the conclusion of the experiments.
100	100	0·666	15·7	173	
200	100	0·666	15·3	169	
300	100	0·664	15·2	167	
400	100	0·653	14·7	165	
500	100	0·640	13·7	157	
600	100	0·634	13·3	154	
700	100	0·630	13·1	153	
800	100	0·620	12·5	148	

DIAGRAM TO TABLE III.



At the conclusion of this experiment, the useful effect had fallen to 57·1 per cent., and the strength of light to 51·5 per cent. of its original value. The greatest difference in the strength of the light amounts to 11·75 candles; the mean light during the 800 hours was 14·94 candles; and the mean useful effect 167·7 normal candles per electric horse-power. The increase of resistance was 10·8 per cent.

If these results are compared with those in Table II. A, the latter, in spite of the somewhat smaller useful effect must be regarded as more favourable, because the decrease of the light is not merely smaller but considerably more regular.

B.—LAMPS WITH PREPARED FILAMENTS.

Time of burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	100	0·552	25·0	333	All the ten lamps in existence at the conclusion of the experiments.
100	100	0·550	22·5	300	
200	100	0·550	22·0	290	
300	100	0·548	21·0	282	
400	100	0·547	20·0	270	
500	100	0·545	18·6	251	
600	100	0·545	17·1	230	
700	100	0·540	16·0	218	
800	100	0·532	15·3	210	

Here the greatest difference in the strength of the light is 9·7 candles; the increase of resistance is 3·8 per cent.: the mean strength of light during the experiment was 19·67 candles, and the mean useful effect per electric horse-power 264·1 candles. After burning for 800 hours, the useful effect retained 63·1, and the strength of light 61·2 per cent. of its original value.

The diagram to Table III. illustrates these relations in the same manner as was done above in Diagram II.

On comparing the curves II. B and III. B (prepared filaments) it appears in the first place that in the latter (where the initial useful effect is 340 normal candles per electric horse-power) we obtain a better mean useful effect than in the curve II. B, where the useful effect begins with 244 candles per horse-power. The mean useful effects are as 264·1 : 230·1, or as 100 : 87·1.

The curve II. B is, however, characterised by a far greater constancy and uniformity. Even if we overlook the circumstance that lamps prepared according to the curve II. B, would last much longer than lamps made after III. B, the firm, Siemens and Halske, must doubt that the former (in accordance with curve II.) are the more rational, since a fall of the strength of light down to 61 per cent. of the initial value is inadmissible in practice. The circumstance is peculiar that during the same time of activity (800 hours), the increase of resistance in the more intensely heated lamps (Tables III. A and III. B) is less than in the less heated lamps (Tables II. A and II. B). It follows that the decrease of the strength of light in the former case depends to a greater extent upon coating than it does in the latter. The principal cause, however, of the decrease of light, is in all cases the increase of resistance.

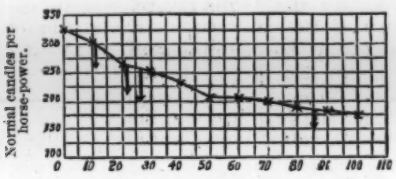
The curves II. A and III. A (unprepared filaments) strike us in the first place by their peculiarly irregular course. It is surprising that in spite of the very different initial values of the useful effects after burning 100 hours, they reach a tolerably complete approximation. In both cases, the effect after 100 hours was rather less than 180 candles per electric horse-power, whilst the corresponding initial values were 260 and 220. For the further explanation of these circumstances, it seemed desirable to examine the behaviour of such lamps at higher temperatures, or with higher initial effects.

This experiment was conducted with 10 lamps, the means of the measurements of the single lamps being given in the table. As the point here was to examine the initial behaviour of the lamps, the experiments were closed after the lapse of 100 hours, while measurements were made every 10 hours.

TABLE IV.—UNPREPARED CARBONS.

Burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power	Remarks.
0	115	0·863	44·2	328	One lamp burnt out after 11½ hours; 1 after 22 hours; 1 after 26 hours; and 1 after 85 hours. The remaining 6 still in existence.
10	115	0·817	38·5	303	
20	115	0·808	33·5	265	
30	115	0·806	31·5	251	
40	115	0·806	29·1	231	
50	115	0·806	26·4	209	
60	115	0·806	26·0	206	
70	115	0·806	25·3	201	
80	115	0·801	24·1	192	
90	115	0·793	22·8	181	
100	115	0·795	20·7	175	

DIAGRAM TO TABLE IV.



Hours burning.

The four arrows pointing downwards show the times when a lamp burnt out.

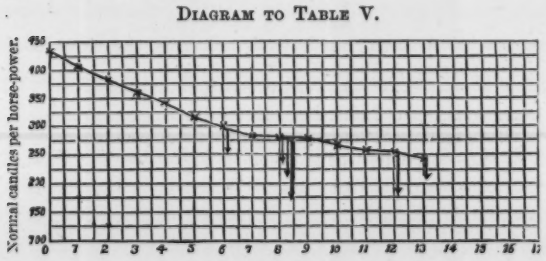
The course of the curve IV. shows that, in this case, also, the useful effect declined after about 100 hours to the same amount as in II. A., and III A.

Finally, in a last prolonged experiment the course of the curve V. was ascertained at a high initial effect. The corresponding table V. shows the mean of the measurements of 6 lamps. The duration of the lamps, in accordance with the higher temperature of the filaments was very brief, as by the end of 13 hours the last of them was burnt out. The measurements were made hourly.

TABLE V.—LAMPS WITH UNPREPARED FILAMENTS.

Burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power	Remarks.
0	123	0·932	68·4	438	One lamp burnt out in 6 hours 12 minutes; another in 8 hours 6 minutes; another in 8¼; a fourth in 8 hours 20 minutes; a fifth in 12 hours 12 minutes, and the last in 13 hours 4 minutes.
1	123	0·929	64·6	412	
2	123	0·929	60·4	386	
3	123	0·930	56·9	360	
4	123	0·924	49·9	323	
5	123	0·922	45·1	293	
6	123	0·924	42·8	277	
7	123	0·910	39·9	262	
8	123	0·907	38·9	257	
9	123	0·885	36·5	256	
10	123	0·880	36·3	247	
11	123	0·880	34·65	235	
12	123	0·880	33·7	229	
13	123	0·860	31·9	222	

DIAGRAM TO TABLE V.



Hours burning.

The arrows pointing downwards indicate the points at which each lamp burst.

The course of this curve, V, shows so decided a decrease in the effect in a few hours, as to render it probable that in 100 hours the effect would not have been greater than in II. A, III. A, and IV., if the lamps had held out so long.

If we collate the results obtained from the lamps with unprepared carbon filaments, we arrive at the conclusion that it is useless to send out these lamps with a higher initial effect than 170 normal candles per electric horse-power. Consequently, the basis of those calculations, which have the object of ascertaining the most suitable values for their duration and effect in proportion to the price, are perfectly deceptive.

From the curves B, it appears that the process according to which Siemens and Halske's glow lamps are prepared offers great advantages. Heretofore, it was merely shown that these lamps at an equal temperature threw out a much more economical light than lamps with unprepared filaments. But the present experiments have shown that these lamps possess, in a high degree, the property of maintaining a high useful effect during the time that it lasts, and of giving out a uniform light.

It has been pointed out above that the Siemens and Halske lamps at 100 volts, and of 16 candle-power, are prepared according to curve II. B, and not according to curve II. A, though the mean effect is here somewhat better. It may be appropriate to remark here that lamps on various systems have made their appearance in commerce which are praised as having an unusually high useful effect. This is given as 2½ and 2¼ volt-ampéres per normal candle. The properties of such lamps at 100 volts and 16 candles might, in the best case, be shown by the curve, III. B. If the effects of this curve, which have hitherto been expressed in normal candles per horse-power, are calculated in volt-ampères per normal candle, we find for the initial effect 2·1 volt-ampères per normal candle, and for the mean effect 2·8, whilst for the curve, II. B (normal curve for the Siemens and Halske lamps), the corresponding values are 3·1 and 3·3.

Though there may be no doubt that the so-called 2¼ volt-ampère lamps may be exceedingly durable, it will be plain, from what has been already explained, that it is not advisable to go below 3 volt-ampères per normal candle.

This remark must, however, be restricted for the present to the 16 candle lamps at 100 volts, and all lamps which have filaments of slender section. It has been found that the above-mentioned method of preparing filaments is still better adapted for thick carbons, and that the results thus obtained are still more favourable. On this question I purpose making further communications after the conclusion of the experiments.

One more remark in conclusion. In the above exposition, prepared filaments (on Siemens and Halske's system) were simply contrasted with unprepared filaments. The objection may be raised that the researches on the latter are confined to a simple material (bamboo) that the lamps used in this investigation differ from the Siemens and Halske lamps in other details, and that possibly the last circumstance may have affected the form of the curves.

It cannot, however, be assumed that there exist carbonised fibres surpassing the bamboo-fibre in strength and applicability for use in glow lamps.

To the difficulty of testing the bamboo filaments in lamps constructed, in other respects, on the Siemens and Halske pattern, I have already referred. Still, the experiment shall be carried out, though I entertain no doubt but that the characteristic peculiarities of that fibre will re-appear in this case also. — *Elektrotech. Zeitschrift.*

A Lengthy Run.— A Ball dynamo, with 10-arc lamps, was recently run 36 days and nights without a stop, by Jones, Denton & Co., contractors on the new Croton aqueduct, in lighting their tunnel work. This, says the New York *Electrical Review*, is considered an extraordinary performance by electric light men.

CENTRAL STATION LIGHTING IN SWITZERLAND AND ITALY.

WE have been favoured by Messrs. Ganz & Co., of Budapest, with a description of central stations for electric lighting over large areas which they are now carrying out with their self-exciting alternate current dynamos and the transformers of Zipernowski and Deri in Lucerne, Rome, and Milan. From the plan of the installation being erected at Lucerne, it seems that the central station will be at Thorenberg, at a distance of about five miles from Lucerne. At Thorenberg there is available water-power up to 600 horse-power; and this will be utilised by means of two turbines for transmitting the current for lighting and power.

On the same plan is shown the disposition of the plant in the central station at Thorenberg. Messrs. Ganz are building two self-exciting alternate current dynamos for this installation, and these, running at a speed of 250 revolutions per minute, will each yield a current of from 35 to 38 ampères, at a potential of 1,800 volts. One of these dynamos will be held in reserve, to be called into requisition when necessary. At a later period it is intended to enlarge the plant to give 400 horse-power; and, in view of this, the space necessary for the erection of two more dynamos of the same type has been cleared.

In order to prevent the possibility of any stoppage in the supply of current, even in case of the hydraulic machinery getting out of order (as, for instance, by the freezing of the water in severe winter seasons), additional steam engines and boilers, to act only as a reserve for such an occurrence, will be erected.

A double switch in the engine room will facilitate the connection of any conductor with any of the dynamos. The primary conductors will be four naked copper wires of 6 mm. gauge, and these will be carried on telegraph poles. The central station itself will be lit up by 15 incandescent lamps, fed by a special small transformer. At 2·4 kilometres from Thorenberg will be placed a second transformer of 1,500 watts, to supply current to supply 40 lamps in the "Fluhmühle," the property of Messrs. Gebrüder, Troller & Co., who are also the owners of the central station in Thorenberg, and the contractors for the supply of the electric light to the consumers. The next secondary station will be at a distance of 2·2 kilometres from the "Fluhmühle," and consequently at a total distance of 4·6 kilometres from the central station. Two first-rate hotels will be lighted, the "Schweizerhof," and the "Luzernerhof," where seven transformers, each of 7,000 watts capacity, sufficient for 200 lamps of 10 C.P., will be placed in various parts of the buildings.

Besides these secondary stations, the electric lighting of several other hotels and public buildings is projected, to be executed at a later time.

The Societa Anglo-Romano per l'Illuminatione di Roma Col Gaz ed altri Sistemi (formerly called simply Societa Anglo-Romano per l'Illuminatione a Gaz di Roma), is establishing an electric lighting plant for lighting several public and private buildings with a total of 12,000 incandescence lamps, 1,500 of which are expected to be in working order in May next. For the purposes of this installation, Messrs. Ganz & Co. have in hand two self-exciting alternate current dynamos of the same type and capacity as those destined for Lucerne, one of the dynamos in this case also to serve as a spare machine. These dynamos will be driven by steam engines, mounted on a common shaft with the respective dynamos. The electric lighting plant will be erected in the gas works of the Anglo-Romano Company, and the current will be conveyed to a maximum distance of about three kilometres.

The third central station installation, to be erected at Milan, will be an enlargement of the already existing central station of the Societa Generale Italiana di Elettricitá Systema Edison; and, as with the Edison low-tension system the current cannot be economically conveyed to distances exceeding 500 or 600 metres, the company will employ Messrs. Ganz's novel system of distributing electrical energy by the aid of transformers, for the lighting of such buildings as are situated at long distances from the central station. By May, 1886, the Theatro Dal Verme is to be fitted with the electric light, and supplied by transformers.

RESISTANCE OF COPPER WIRE.

IN most text books on electricity, and in many periodicals, says Mr. Carl Hering, writing in the New York *Electrician and Electrical Engineer*, values are given for the resistance, or the conductivity, of copper wire, but owing to the difference in the units used, and to the fact that the resistance varies with the temperature, these values are often very unreliable unless the units used and the temperature, are stated in each case. Even if they are stated, the reductions necessary are often so complicated that it is very troublesome to use these values. If they are reduced to the same units, there is frequently a discrepancy found, so that the practical engineer is often in doubt, not only which value to use, but also to what extent he can depend upon it.

To enable the engineer to compare these values better, and in order to get a fair mean value, the writer has collected, in the last few years, a large number of different values given by various authorities, and has reduced them all to the same units in the following table, thus enabling a fair comparison and selection to be made.

The value to which they have all been reduced is what might be called the *specific resistance*, that is *the resistance in legal ohms, of a wire of one square millimetre cross section, and one metre length, at the temperature 0° Centigrade.* Calling this value θ, the formulæ for using it with other units, such as feet and inches, may readily be deduced and can be reduced to such forms as to facilitate calculations very much.

There is also given in the table the conductivity of the wire calculated from the specific resistance; it expresses the number of times that the copper conducts better than mercury, or in other words, it is the ratio of the conductivity of copper to that of mercury.

In many of the statements from which these values were calculated, the data given was incomplete, so that the writer had to assume certain factors as being most probably the ones understood. In all cases the original data is given, enabling anyone to make the calculations, in case the factors assumed are not the correct ones.

In reducing them all to 0° temperature, the following formula was used:—

$$R_0 = R_t - R_t\, t^\circ\, 0{\cdot}0037$$

t° being in centigrade degrees. The constant 0·0037 was taken as a fair mean of a large number of independent statements. It is evident, however, that if a slightly different value is taken for this constant, it will not affect the result very much, as it does not enter as a direct factor.

The factors used in the reductions are as follows:—

1 legal ohm = 1·0112 B. A. units.
1 B. A. unit = ·9889 legal ohms.
1 legal ohm = 1·06 Siemens units.
1 B. A. unit = 1·0483 Siemens units.
1 ohm as used in Germany = 1·0615 Siemens units.

The first and second values are those given by the Secretary of the British Association, on their standard resistances.

It will be noticed that the values coming from the same authority, but compiled from different sources are not alike. This may be due to the fact that they were incorrectly stated in the source from which they were taken by the writer, but it is more probable that they are values obtained from different experiments at different times.

In many cases values are given for pure copper, while in practice commercial copper is always used, the resistance of which is always greater. Several values for commercial copper are given and show what allowances may be made in practice.

The numbers in the first column refer to the paragraphs below, in which the authority and any other remarks are given.

TABLE.

θ = resistance in legal ohms of 1 metre of copper wire with 1 square mm. cross section at 0° C.

K = conductivity at 0° C. as compared with mercury at 0° C.

No.	θ	K	Remarks.
1	0·01618	58·31	annealed
1	0·01655	57·01	hard
1	0·01598	59·05	annealed
1	0·01633	57·73	hard
2	0·01558	60·55	pure
3	0·01528	61·73	soft, pure
3	0·01566	60·24	hard, pure
4	0·01623	58·12	pure
4	0·01642	57·45	pure
5	0·01631	57·84	pure, soft
6	0·01611	58·56	pure
7	0·01528	61·73	soft, pure
7	0·01565	60·27	hard, pure
8	0·01616	58·38	pure
9	0·01641	57·49	pure, soft
9	0·01674	56·34	98 per cent.
9	0·01727	54·61	95 ,,
10	0·01570	60·09	commercial
11	0·01603	58·85	commercial
12	0·01583	59·59	pure
12	0·01616	58·38	98 per cent.
12	0·01765	53·45	90 ,,
13	0·01573	59·97	pure
14	0·01655	57·00	commercial
14	0·01572	60·00	commercial
15	0·01528	61·73	soft, pure
15	0·01565	60·27	hard, pure
16	0·0243		
16	0·02386		
16	0·01959		

1. Matthiessen. Resistance of one metre of annealed copper wire of 1 mm. diameter, at 0° C., is 0·02057 ohms. Hard wire, 0·02104 ohms. From Uppenborn's Kalendar. In the first two values the ohm is assumed equal to 1·0615 Siemens units, as that is used throughout the book. In the second two the B. A. unit is taken, it being most probably the one understood.

2. Matthiessen. One mile of pure copper wire $\frac{1}{10}$th inch diameter, at 15·5° C., has 13·59 ohms. The ohm is assumed to be the B. A. unit. From the report of the British Association Committee on Electrical Standards, 1873. This value is employed in the table calculated by Mr. Prescott and published in the *Electrician and Electrical Engineer*, June, 1885.

3. Matthiessen. Pure copper as compared with mercury: soft 0·0162 Siemens units, hard 0·0166 Siemens units. This, no doubt, means at 0° C.

4. Matthiessen. One metre of pure copper wire of one gram weight, at 0° C., has 0·1469 ohms, sp. gr. 8·95. The ohm is assumed to be the B. A. unit. Another value given is the resistance in absolute units, equal to 1642. These values are quoted by Maxwell and Kohlrausch.

5 Kohlrausch. Pure, soft copper has a conductivity at 18° C. equal to 54 approximately, as compared with mercury at 0° C. The ohm is given as 1·06 Siemens units.

6. Pure copper wire, per mile at 60° F., has $\frac{54892}{d^2}$ ohms. The ohm is assumed to be the B. A. unit. d is, no doubt, the diameter expressed in mils or thousandths of an inch.

7. One metre of soft copper wire of one square mm. cross section at 0° C. has 0·01526 ohms. Hard copper 0·01563 ohms. From Uppenborn's Kalendar. The ohm is taken equal to 1·0615 Siemens units. Pure copper is no doubt meant.

8. Taken from Sidney B. Paine's table, published in many price catalogues. 1,000 feet of No. 16 pure copper wire at 75° F. with a diameter of 0·050820 inches, has a resistance of 4·179 ohms. The ohm is assumed to be the B. A. unit.

9. Taken from a table published in the London ELECTRICAL REVIEW, November 3rd, 1883. One metre of No. 16 pure, soft drawn copper wire with a diameter of 0·064 inches at a temperature of 15° C. has a resistance of 0·00824 ohms. The ohm is assumed to be the B. A. unit. The same author states that the best wire used in practice has a conductivity of 98 per cent. of this value; while ordinary good wire has only 95 per cent. Both these values are given.

10. Commercial copper wire, one metre long, and one square mm. cross section at 15° C. has 0·0166 ohms. Uppenborn's Kalendar. The ohm is assumed to be equal to 1·0615 Siemens units.

11. Quoted as being used in the Siemens factory. One ohm is equal to 48·5 metres of copper wire of one mm. diameter, at 0° C. The same author gives the ohm equal to 1·0493 Siemens units. This value was used in the reduction. Commercial copper is assumed.

12. From London *Electrician*. 100 yards of pure copper wire of d inches in diameter, has a resistance of $\frac{0·003118}{d^2}$ ohms. 98 per cent. copper has $\frac{0·003185}{d^2}$ ohms. 90 per cent. has $\frac{0·003478}{d^2}$ ohms. The ohm is assumed to be the B. A. unit. The values are assumed to be at the ordinary temperature of 20° C.

13. From London *Electrician*. 1,000 feet of pure copper wire with a diameter of 0·12849 has 0·6259 ohms. The diameter is assumed to be in inches, and the temperature to be about 20° C. The ohm is assumed to be the B. A. unit.

14. Hesse, one of the largest manufacturers of copper wire in Germany, guarantees his wire to have a conductivity of from 57 to 60. This is said to be above the usual values.

15. One metre of soft copper wire of one sq. mm. cross section, has 0·01526 ohms. Hard copper, 0·01563 ohms. The ohm is assumed to be equal to 1·0615 Siemens units. The wire is assumed to be pure and at 0° C.

16. Three different values determined by Weber in Munich, of copper from different sources to show the variation. The last one is from Hesse, Germany. They are quoted as specific resistances.

Representing the specific resistance as given and defined in this table, by θ, the following formulæ will enable one to calculate either the resistance in legal ohms, the length, or the size of a copper wire, any two of the factors being given.

Let

R = the resistance in legal ohms.
L = the length in feet.
l = the length in metres.
D = the diameter in inches.
d = the diameter in millimetres.
A = the cross section in square inches.
a = the cross section in square millimetres.

The temperature is assumed to be 0° C. unless otherwise stated.

$$R = ·0004724 \frac{L\theta}{A}$$

$$R = \frac{l\theta}{a}$$

$$R = ·0006015 \frac{L\theta}{D^2}$$

$$R = 1·273 \frac{l\theta}{d^2}$$

$$L = 1662 \frac{R D^2}{\theta}$$

$$L = 2117 \frac{R A}{\theta}$$

$$l = ·7854 \frac{R d^2}{\theta}$$

$$l = \frac{R\,a}{\theta}$$

$$D = \cdot02453\sqrt{\frac{L\,\theta}{R}}$$

$$d = 1\cdot128\sqrt{\frac{l\,\theta}{R}}$$

$$A = \cdot0004724\,\frac{L\,\theta}{R}$$

$$a = \frac{l\,\theta}{R}$$

The temperature correction may be introduced into the equation, but it complicates it considerably. The most convenient way to correct for temperature is to calculate the resistance at zero first and then correct by means of the formula—

$$R_t = R_0 + R_0\,t\,0\cdot0037$$

in which t is in centigrade degrees. For reducing from a high temperature to zero, the following may be used :

$$R_0 = R_t - R_t\,t\,0\cdot0037.$$

Neither of these are absolutely correct, but are near enough for all practical purposes.

Assuming as a mean value of θ for ordinary good commercial copper 0·0162, and assuming a mean temperature of 20° C., equal to about 68° F., the above formulæ may be still further reduced to the following—

$$R = \cdot0822\,\frac{L}{10{,}000\,A}$$

$$R = \cdot0174\,\frac{l}{A}$$

$$R = \cdot105\,\frac{L}{10{,}000\,D^2}$$

$$R = \cdot0222\,\frac{l}{d^2}$$

$$L = 95500.\ R\,D^2$$

$$L = 122000.\ R\,A$$

$$l = 45\cdot1\,R\,d^2 = \text{approx.}\ \frac{90\,R\,d^2}{2}$$

$$l = 57\cdot5\,R\,a$$

$$D = \cdot00324\sqrt{\frac{L}{R}}$$

$$d = \cdot149\sqrt{\frac{l}{R}}$$

$$A = \cdot0822\,\frac{L}{10{,}000\,R}$$

$$a = \cdot0174\,\frac{l}{R}$$

By taking the specific resistance at 0·0157 which, from the table, is seen to be still above many values given for pure soft copper, and therefore will not fall much below that of good commercial copper, the third one of the above formulæ reduces to the very simple and convenient form,

$$R = \frac{L}{100{,}000\,D^2}$$

if the temperature is taken at about 60° F.

Furthermore, if the diameter is taken in mils., the formula reduces to the following form, which could hardly be simpler, namely :

$$R = 10\,\frac{L}{D^2}$$

in which R = resistance at 60° F. in legal ohms.
L = length in feet.
D = diameter in mils.

The resistances obtained from this formula will be slightly lower than those given in the tables of Prescott and Paine, because the temperature is taken lower, in order to reduce the constant to 10. If they are reduced to the same temperature they will be very little higher than those of Prescott and somewhat lower than those of Paine.

ELECTRIC LIGHT ENGINES AT THE FIRST AVENUE HOTEL, HOLBORN.

THE *Engineer* publishes engravings of one of a pair of "Invincible" compound Woolf engines, erected at First Avenue Hotel, Holborn, by Messrs. John and Henry Gwynne, Hammersmith Ironworks, to provide motive power for the electric lighting of the whole building by incandescent lamps, and remarks : "This installation is at this date probably the most perfect and successful yet carried out by private enterprise. We are now accustomed to the electric light in public buildings and large dining halls, but we believe that at the Avenue Hotel the incandescent lamp was first introduced to private apartments and bed rooms. The electric current is provided by two dynamos of Ferranti type, each driven by its own engine, without countershafts, and with two broad bands from wrought-iron pulleys on an extension of the crank shaft. We understand that the number of lamps within this hotel building is over 1,000.

"The engines are designed to run up to 300 revolutions per minute, and each is capable of indicating 120 horse-power, with 100 lbs. steam. The steam cylinders are 11 inches and 17 inches diameter, with 13 inch stroke. Steam is provided by two very fine steel boilers, built by Messrs. Adamson ; their diameter is 7 feet ; length, 27 feet ; and daily working pressure, 100 lb. per square inch. One boiler usually supplies steam to both engines. The exhaust steam passes through a large feed-water heater before going to waste. The heater also serves to deaden the beat of the engines, but as the steam is well expanded the noise of the exhaust is slight. During the evening both engines work together, aud in these dark days one or other is constantly at work during the 24 hours. Under present arrangements the speed required of these engines is only 180 to 200 revolutions per minute.

"Since the opening of First Avenue Hotel, over two years ago, not the smallest mishap or breakage has occurred, and no stoppage of machinery has ever been caused by any fault whatever in the engines. During the early days of the installation, before the wiring had been perfected, the engines were most severely tried ; more than once when making 280 revolutions per minute they were suddenly brought to a standstill with full steam on, and to-day they work as smoothly and perfectly as when first started. This result has been secured partly by very careful designing, and for the rest by putting in workmanship and material as perfect as the most fastidious can desire. Indeed, the most casual examination of the engines reveals careful and independent thought.

"The moving parts are the fewest possible for a compound engine, consistent with an economical distribution of steam. The surfaces are most abnormally large—some engineers might say absurdly large—but Messrs. J. and H. Gwynne are probably well able to judge as to the requirements of this class of engine. All the moving parts are of steel ; the fly-wheel discs are forced on the crank webs, then balanced by exact experiment. The plan of connecting two piston rods to one crosshead and using one connecting rod only is not novel, but in these engines the arrangement has been carried out in a very workmanlike manner. Nevertheless, the connection has more than once been dubbed 'unmechanical' by critics, 'and sure to give trouble.' The initial load is obviously far from equal in both cylinders ; the average load may be equal, in practice it is seldom equal, and constantly varies with the total load. Messrs. J. and H. Gwynne do not advance the design as suitable for large engines, but in engines like those under notice and a series of smaller engines of the same type made at Hammersmith, every necessary provision is made to avoid trouble from unequal loads in the cylinders.

"Messrs. Gwynne tell us a rather amusing story bearing directly on this point. The engines at the First Avenue Hotel are called Nos. 1 and 2. The erector who put both engines in place at the hotel

particularly fancied No. 2 because he had put together the parts of No. 2, while another man had performed this office for No. 1. Both engines were duly started, both worked very well indeed, but the erector would have it that No. 2 worked more smoothly than No. 1, and granting a difference, No. 2 was really the better. No. 1 was indicated and diagrams found all right. Three months elapsed before diagrams were taken from No. 2; the high-pressure cylinder gave a straight line and the low-pressure cylinder proved to be giving all the power which the engine developed. The high-pressure slide of erector's favourite, No. 2, owing to a most trifling oversight, did not reach its face, and for three months the low-pressure cylinder did all the work. So much for the critics."

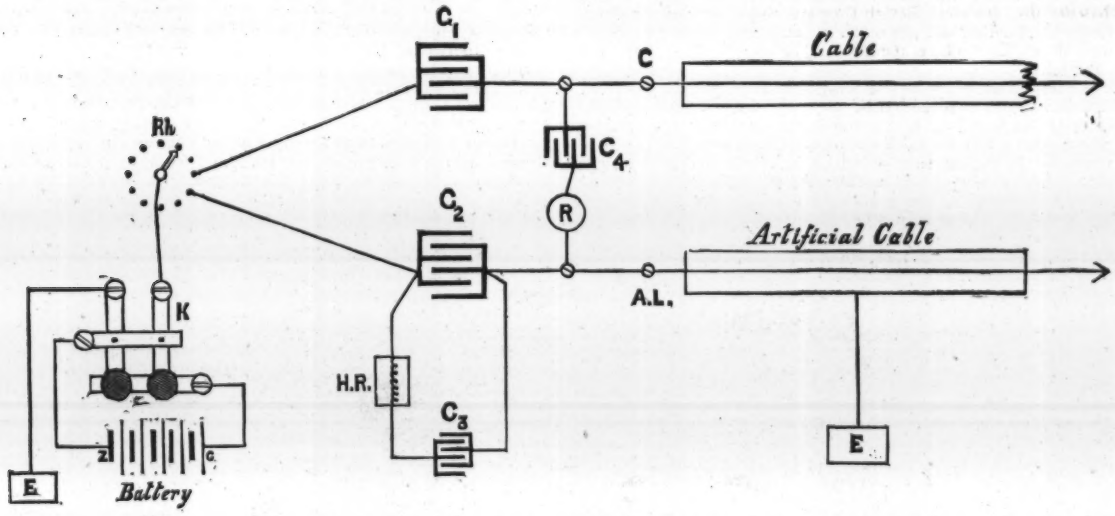
MUIRHEAD'S IMPROVED CABLE DUPLEX SYSTEM.

IT has been found practicable to establish and maintain a balance on short cables (up to 500 miles) without using the bridge wires by merely adjusting the capacity of the condensers, C_1 and C_2, relatively to each other. But Mr. Muirhead has since discovered that on very long cables such as those recently laid between Canso in Nova Scotia and Waterville in Ireland (the Mackay-Bennett Cables), that it is insufficient and extremely difficult to effect and maintain in practice a sufficiently close balance by merely having the condensers, C_1 and C_2 (sending condensers), adjusted for capacity. In order to effect a balance sufficiently exact for the purpose of obtaining the greatest possible speed of working it is necessary not only that the capacity of the condenser, C_1, placed between the key, K, and submarine cable, C, should be of the required ratio to that of the condenser, C_2, between the key and the artificial cable, A, L, but also that their times of charging and discharging should be the same.

As it is practically impossible to construct or build up a number of sets of large condensers, even out of exactly the same materials, so that their rates of absorption of charge shall be the same throughout, Mr. Muirhead resorts to the following device, which is shown in the fig.

A rheostat, Rh, of low resistances ($\frac{1}{4}$ ohms) is interposed between the signalling key, K, and the condensers C_1 and C_2. The cable, C, and the artificial cable, A, L, are connected with these condensers in the manner shown, and a condenser, C_4, and receiving instrument, R, are inserted in the circuit between the real and artificial cables. B represents the battery, and E the earth. To one of the two condensers, say C_2, is attached another and supplementary condenser, C_3, which is subdivided into small parts; and inserted between one terminal of it and one terminal of C_2, is a set of coils, marked, H, R, in the diagram, of high resistance (say of from 1,000 to 200,000 ohms); the other terminal of C_3, is connected by a simple wire with the corresponding terminal of C_2, as shown. In effecting the balance, the artificial cable, A, L, is first of all made electrically equal to the cable, C. The condensers, C_1 and C_2, are then inserted, and their capacities adjusted by means of a subdivided condenser, C_3. After obtaining in this way the nearest balance, a slight increase is made in the capacity of C_3, say by ·1 microfarad, and by trials the amount of resistance required in the resistance coils, H, R, is ascertained. This produces a flow of charge in the circuit of C_2 and C_3, together equal to that flowing into the condenser, C_1.

By way of illustrating and explaining this improved method of balancing, the conditions required in balancing one of the above-mentioned Mackay-Bennett cables may be mentioned; they are as follows:—On the northerly of the two main cables, C_1 is equal to 120 microfarads, C_2 to 120 microfarads, C_3 to ·15 microfarad, and the resistance in H, R, 107,000 ohms. In this case, the combination of the small capacity in



C_3, with the resistance of the coils, H, R, produces a flow of charge of slower rate, which, superposed upon that of the condenser, C_2, produces the same effect upon the differential arrangement as the charging and discharging of the condenser C_1.

ELECTRICITY IN WARFARE.*

(*Continued from page* 519.)

Within the past three years, the superiority of the incandescent electric light over all other lights for ship use has become more and more evident, and nearly all first-class merchant steamships launched, and all men-of-war, are fitted with electric lights. In men-of-war, this light has even more advantages than in merchant ships, by reason of its safety in illuminating magazines, shell rooms, torpedo store-rooms, etc., and the ease and speed with which it can be used in signalling at night.

For some time the electric light was declared unsuitable for naval use, the reason being urged that if the wire carrying the current should be shot away in action, the whole ship would be plunged into darkness, and that the same thing would happen if any accident should befal the dynamo generating the current. The answer to this very sensible criticism is that—1st: different circuits must be arranged for different parts of the ship, so that an

* Lecture delivered before the Franklin Institute, November 13th, 1885, by Lieut. B. A. Fiske, U. S. Navy.

accident in any part of the ship will affect that part only; 2nd: that the wires carrying the current must be arranged in duplicate, so that even in case one wire is shot away, the lights will burn as brightly as ever, since the other wire remains, and is of sufficient size to carry all the current; 3rd: it is very easy to repair a break in a copper wire, even if it be shot away, the only thing necessary being to bridge over the break by a wire a few inches long, whose ends can be clamped, spliced, or even twisted on to the broken conductor on each side of the break. As to the danger to be feared from accident to the dynamo and engine, this can be guarded against in two ways—1st: by placing the dynamos and engines in a place as well protected as that occupied by the main boilers and engines of the ship, preferably near the engines, below the water line, and under a protective deck, and this place should be provided in laying down the original plans of the ship; 2nd: by not placing dependence on one dynamo and engine alone, but by dividing the total work among three or four, so that in case of accident to one, the ship will have the benefit of all the others. To this end, all the dynamos should, of course, be of the same electromotive force, and feed into the same mains, from which all lamps draw their supply, and which are fed by feeders from the dynamos at different points, so that accident to the mains in one part of the ship will affect that part only.

But it is the arc light, used as what is called a search light, that is most valuable in warfare; a search light being simply a very powerful arc light, so arranged with a catadioptric mirror, that it throws out a very concentrated beam of light, and so mounted that this light can be cast in any desired direction, and made to illuminate any locality which it is desired to inspect. I believe the first use made of search lights was in the siege of Paris in the Franco-Prussian war, when the French employed them to discover the operations of the besieging army at night. Their value, from a military point of view, was so evident that other nations took the hint and introduced them into their military and naval services. Since then, their use has been extending, more probably for ship use than for use on shore, though they are also employed considerably in forts guarding the approach to harbours, to watch for the approach of hostile fleets, torpedo boats, or countermining expeditions at night.

For the use of an army in the field, search lights are mounted on suitable wagons, together with portable boilers and engines, so that they can be taken on the march, moved to any part of the field, the top of a hill for instance, and employed at night whenever desired. It is clear that a search light might often be very useful in doing such work as searching for wounded after a battle, examining the nature of the ground in a comparatively unknown country, watching the enemy when a surprise might be anticipated, guarding against a sortie from a beleagured fort or city, etc., on many occasions, in fact, when the darkness of the night might be a hindrance to the operations of any army or an element of insecurity.

On board men-of-war, the principal use of the search light has been in watching for the attack of torpedo boats; but the experiments in Bantry Bay last July showed that it was often useful in detecting the approach of hostile ships, in aiding the sighting of guns at night by bringing the target out clearly, and in embarrassing the operations of a torpedo boat or ship in trying to force a passage up a channel, by dazzling the eyes of the enemy one instant and leaving them in total darkness the next.

It was related that in Africa some three years ago an attack on a fort was frustrated by a single search light. The barbarians advanced to the assault brave and determined, under cover of darkness, but were suddenly terrified by finding themselves enveloped in an awful and miraculous light which turned night into day. Halting for an instant, they covered their eyes to shield them from its dazzling whiteness, then suddenly turned and fled in panic.

But even had they not been barbarians, even had they been trained soldiers of a highly civilised people, how bewildered they would have been to find themselves suddenly in such a brilliant light that their eyes were blinded so that they could not see to pick their way; and then, in a few seconds, just as the pupils of their eyes had contracted under the influence of the light, to find themselves suddenly in total darkness!

Such alternations of dazzling light and black darkness would render the march of an attacking force over a broken country toward a fort a very difficult undertaking, for it should not be forgotten how dependent we are upon our eyes, for our most simple actions, and how much our eyes assist us, even in the dark.

It may be pointed out here, that the search light, like all other military instruments, must be used with judgment. It should not be used, for instance, when it is important to keep your position secret from the enemy, unless the advantages of observing him outweigh the disadvantage of disclosing your own position, or unless you can immediately extinguish your light, and change your position. In order to use the search light effectively on board ship, there should be four on each side of the ship.

Search lamps are of much higher power than any other lamps that have ever been made, and the effect of the white cylinder of light, as it touches up the different points of the land or sea over which it is made to rapidly pass, is striking and beautiful in the extreme. The people of Philadelphia may remember the naval search light with which I used to illuminate the city last autumn, and do not have to be assured of its power and beauty. The best idea that I got of its illuminating effect was got one night when I went to the tower of the Pennsylvania Railroad depot, and watched the light stationed at the Electrical Exhibition building on Thirty-second Street. The ray of light, when turned at right angles to my direction, looked like a silver arrow going through the sky, and when it was turned on me, I could read the fine print of a railroad time-table at arms' length.

For signalling at night, incandescent lights and search lights have both been used, the search lights being employed to reach long distances, or to reach points hidden by hills or other intervening objects. In using the search light in this case, the beam is thrown into the sky, and signals are made by showing long and short flashes, or by interrupting the beam in accordance with any preconcerted code. Flashes from the search light which I had at the Electrical Exhibition last autumn were seen from a distance of thirty miles.

In using incandescent lamps for night signalling, the simplest way is to arrange a keyboard with keys marked with certain numbers, indicating the numbers of lamps arranged in a prominent position, which will burn while that key is being pressed. If it be desired to signal the number 5,348, for instance, meaning, let us suppose, "Prepare to receive a torpedo attack," it is only necessary to press in succession keys marked 5, 3, 4, and 8, and the light of 5, 3, 4, and 8 lamps will successively blaze out and expire. Other codes, of course, can be used; the Morse code, for instance, in which a dash can be denoted by two lamps and a dot by one. One lamp could, of course, be used, the dot being denoted by a short flash and a dash by a long flash; but it is found best, practically, not to use time intervals in optical telegraphy.

Electric lights have been used considerably of late in photographing the bores of great guns. Views can thus be obtained of any part of the bore, showing whether the gun has been accurately bored and rifled, and showing how the metal is standing the erosion of the powder gases.

One of the needs arising in modern warfare is means for handling heavy ordnance with speed and precision, and for bringing up ammunition. Guns, carriages, and ammunition have increased so much in weight, that it has become more difficult to handle them quickly than it used to be, and yet the speed of ships has so increased that there is more necessity for handling them quickly. The electric motor will certainly be used for handling ordnance on board ships not very heavily plated with armour, for it is clear that a small wire is a much more convenient way of conveying energy to a motor of any kind, and is much less liable to injury in action than a comparatively large pipe for conveying steam, compressed air, or water under pressure; and, besides, the electric motor is the ideal engine for work on board ship, by reason of its smooth and silent motion, its freedom from dirt and grease, the readiness with which it can be started, stopped and reversed, and its high efficiency.

In forts, Col. Hamilton, U. S. A., says that heavy guns must be worked by dynamo-electric machinery, since some other power than manual power must be employed, and since electricity is better than steam, compressed air, or water under pressure, because it can be conveyed from a central source by a single wire. Now, in forts, it is clear that the dynamos for search-lights and incandescent lights, and for generating power for the electric motors for handling the guns, could be placed in a well-protected spot, and the wires leading therefrom could pass to the guns through underground pipes, where they would be well protected from projectiles, and the guns could be pointed in any desired direction with speed, silence and precision, by the simple turning of a lever or the moving of a switch.

It is probable that, in the near future, every man-of-war and every fort will be fitted with a complete "electrical system," well protected from projectiles, which will include dynamos capable of supplying a very large amount of electrical energy to a system of mains, from which all the incandescent lights, all the search-lights, and all the motors of different sorts can draw the supply of energy requisite for their needs.

Electrical launches have been tried abroad to some extent, and with results which—though not completely satisfactory—give promise of success in the future. These boats are propelled in the same way as other boats—that is, by a propeller revolved by an engine—except that the engine is an electrical, instead of a steam engine. The electrical engine draws its power from what are called storage batteries carried in the boat. These storage batteries are first charged by a dynamo ashore or on board ship, and then are capable of rendering up to the motor the electrical energy stored in them, so that the motor is made to revolve, and thus cause the revolution of the propeller and the advance of the boat through the water. These electrical launches have carried hundreds of people, and have made a speed of about eight knots per hour, and the electric engine has worked perfectly well; but there has been considerable trouble with the storage batteries. Now, these storage batteries are improving every day, and as their defects do not seem irremediable, and as a great number of electricians are devoting study and experiment to them, we may hope that storage batteries will soon be efficient and durable. This done, the electrical launch will certainly replace the steam launch in warfare, by reason of the quickness with which an electrical launch can be got ready, as there are no fires to be lighted, and, above all, by reason of the noiselessness of the electro-motor, and of the fact that in an electrical launch no flame ever flares up above a smoke pipe. With steam torpedo boats this flame frequently betrays them—that is, if the noise of the exhaust has not already done so. In using electrical launches in warfare, two sets of storage batteries will, of course, be necessary, so that one set can be replaced by another, and used while the first set is being recharged.

A novel application of electricity has recently been made in what have been named "electric sights." It is well known that it is difficult to get a sight at an object in the dark—first, because the object itself cannot be distinctly seen, and, second, because the front sight of the gun cannot be distinctly seen. Now, Mr. Gaston Trouvé has recently invented an electric sight no larger than the ordinary front sight of a musket, which consists simply of a filament of fine wire in a glass tube, covered with metal on all sides save at the back. It looks much like an ordinary sight, except to a man looking along the barrel towards the back of the lamp, but a man so looking sees a fine incandescent wire. The battery is said to be no larger than a man's finger, and to be attached to the barrel near the muzzle by simple rubber bands, so arranged that the act of attaching the battery to the barrel automatically makes connection with the sight, and so arranged, also, that the liquid of the battery is out of action except when the musket is brought into a horizontal position for firing.

To throw a good light upon the target, the same inventor has devised a small electric lamp and projector, which is placed on the barrel near the muzzle by rubber bands, the battery being held at the belt of the marksman, with such connections that the act of pressing the butt of the musket against the shoulder completes the electric circuit, and causes a bright cylinder of light to fall on the target, thus bringing it out into strong relief, and enabling the marksman to get as good a shot as in the daytime.

An application of electricity coming somewhat into use abroad in continental armies is in connection with ballooning, which has received there the benefit of considerable attention and experiment. It is well known to all here that balloons have been much used for observing the movements of the enemy from a distance, and now it is reported that not only have balloons been successfully fitted with telephones, for communicating at once to people on the ground the nature of the information gathered, but also with small search lights, by which the ground can be illumined for a considerable distance at night, and the enemy's manœuvres discovered. Incandescent lamps have also been sent up in small, translucent, captive balloons, and under small ordinary captive balloons, and signals have been transmitted to a distance by making and breaking the current according to a preconcerted code.

Yet another way in which electricity will undoubtedly be used in any future war between civilised Powers is in submarine boats, or boats which go beneath the surface of the water, to attack ships below the water line. Though it connot be said that submarine boats have ever yet been successful, still, submarine boats are being improved, and men have always been found willing to risk their lives in them. Some have been devised of late years, in which the propelling power is electricity derived from storage batteries.

In submarine diving the telephone has been used with success in maintaining constant communication between the diver and his attendants above water; and the incandescent lamp, suitably protected, has also been lowered into the water to light him at his work. Submarine diving will certainly play a part in future wars, the diver descending to cut an enemy's torpedo cables, or to inspect or repair damages to submarine mines or to ships.

Progress is now beginning on what have been christened "electrical guns," in which the cartridge contains an electric fuse, which is ignited by pressing an electric push-button on the gun, instead of containing the ordinary percussion primer, which is struck by a hammer or bolt when the trigger is pulled. At present this invention has not reached the practical stage, and the necessity for a battery to fire the cartridge is decidedly an objection. Yet we should remember that the battery required is very small, that it needs very little care, and that it will last a long time. We should also note that an electric gun possesses the great advantage that a better aim can be got with it than with one fired by a trigger-hammer, for the reason that the hard pull of a trigger causes a movement of the barrel, except in the hands of the most highly skilled marksman. Now, this hard pull of the trigger is a necessity, since the hammer or bolt must have considerable mass in order that it may be strong enough to strike the primer with sufficient force to explode it, and having considerable mass, it must have, necessarily, considerable inertia, so that it needs a deep notch in order to hold it firm at full cock when jarred, and this deep notch necessitates a strong pull on the trigger. But with an electric gun the circuit closing parts can be very small and light, and can be put into a recess in the butt of the gun out of the way of chance blows, so that when it is desired to fire, a very light pressure of the finger is all that is needed, and yet, from the small inertia of the parts, a sudden shock will not cause accidental closing of the circuit and firing of the gun.

We have now taken a running survey of the uses of electricity in war, and we find that they include nearly all the uses to which electricity can be put. Warfare now means more than the mere handling and provisioning of troops and ships; it means, in addition, the intelligent employment of scientific instruments. Particularly is this the case with naval warfare, for a modern ship, considered as a whole, is, in itself, the most elaborate, complicated, and powerful machine existing.

Science has made warfare a greater thing than scientists themselves foresaw, for it has put into the hands of our naval and military commanders weapons surpassing in power and length of reach the fabled weapons of mythology. Yet our wonder and admiration at what has been accomplished pale before our wonder and admiration at what will surely be accomplished. Progress is marching with rapid steps. Looking forward to the future with the light the past affords us, we see the promise of great things to come. Let us welcome each new triumph of the discoverer and inventor, and take advantage of every resource that science can suggest. War is a sad necessity, but it comes seldom to a nation known to be prepared. Let us thoroughly prepare ourselves. Then, if war does unfortunately come, we need not fear the issue.

THEORY OF THE WIMSHURST INFLUENCE MACHINE.*

WRITING in the *English Mechanic*, Mr. F. Taafe, of Roscommon, remarks:—

Mr. Wimshurst has added to the debt of gratitude many of us owe him, by kindly communicating the theory of this machine as furnished to him by Mr. A. J. Walter, LL.B., and his having procured the opinion of this gentleman proves his desire to fully elucidate the matter. Thus, I do not think he will consider me captious if I direct his attention to some little facts not quite consistent with the theory of Mr. Walter. This theory is "that assuming an insulated sector, carrrying a charge of + E, to come opposite another sector in contact with a brush, the + E is repelled from the sector in contact, and − E is held bound." So far this seems indisputable; but where does the repelled + E go to? Mr. Walter thinks to the brush at the opposite end of the neutralising rod. Why go there in particular? The plates being neutral, at first have no attraction for it. The rod is not insulated, and the repelled + E may turn in through the spindle and be lost in the frame, or may go along the rod of the other plate to a brush where it is not wanted, and where it would certainly set up an adverse excitement. Does our experience of high-tension electricity lead us to think it so obliging? No. Besides, what if there be no connection between the brushes at all—will the machine work? Yes; even if the brushes do not touch sectors on opposite parts of the plates at the same time. All that is wanted is "that the brushes afford free passage to electricity to come and go as it will." This, Mr. Wimshurst's arrangement does effectively. It is symmetrical in appearance, easy of adjustment, and hard to beat; but it is not a necessity.

Of course, in making these statements I may be supposed to have the proof before me, and I have. Living in the West of Ireland, it would be useless to offer it for inspection; but I can describe the machine for others to construct similar ones, and to contradict me if I am wrong.

The machine has 24 in. discs of common window glass. There is no spindle through them; they are not bored; they are set on independent axles on separate standards, they work in deep slots cut in the standards and have driving pulleys external to the standards, so that a driving band can be slipped off and a plate taken out in a moment. This allows the standing plate to have its E fully examined. The brushes are attached by stout wire to the mahogany frame, but have no metallic contact with each other; they do not touch opposite sectors at same time. The machine in this condition is before me, and is in full working order. I think the theory is not far to seek, and requires no knowledge that is not 40 years old. In giving it I must state much of what is already known; but I think I shall state nothing that is not easily comprehended and easily proved.

On removing the conductors and turning the handle a few times, a drag is felt. The plates seem to encounter some resistance, invisible but there. Several hands being held near the plates, the drag is reduced, and sparks fly freely from certain parts of the plates, while other parts of the plates seem devoid of electricity, thus the plates would appear to be divided electrically into four segments marked by the four brushes. The top and bottom segments seem to have no electricity while the right and left segments have plenty. Reverse the handle, the machine works again; but this time the segments are reversed, the top and bottom segments giving sparks, the lateral segments giving none. Remove the back plate and examine the front plate with the knuckle; it gives a small spark from every sector not in contact with, or quite near to, a brush. Examine with charged electroscope, the plate seems electrically divided *not* into four segments, but into two semi-circles marked by the two brushes of the plate. The left shows, say, − E, the right + E. (This is not always the order.) On replacing the removed plate and again working the machine, we now remove the front plate and examine the back one. The shape of this plate is the same as the front plate exactly. The right and left semicircles hold the same electricity as the right and left semicircles of the front plate. Whence come the dormant segments! It is clear that the semicircles must overlap, as the brush rods cross and the electricity is bound in this overlap, as Mr. Wimshurst states, and as we can prove by a proof plane and electroscope.

Thus, no matter how we turn the handle, there are two segments in which electricity is free, and two segments in which it is bound. From which segments does the electricity arise? To find this out we apply forked conductors to the free segments. The machine works still, but the handle drag is less while the conductors discharge. We then remove the conductors and apply them to the bound segments; the machine at once ceases to act. What do we gather from this? That the electricity is developed

*Practical hints on working the influence machine may be found in the REVIEW for November 21st.—EDS. ELEC. REV.

by the bound segments which are thus the charging segments, and its potential is raised or lowered by the amount of electricity in the free or discharging segments. Now, what determines the position of these charging segments? The position of the brushes; one rule is ever followed: the charging segment for each plate has that plate's brush at the entrance, and the opposite plate's brush at the exit. Mark this well. Now assuming a sector charged with + E to be coming out of the charging segment, it must pass a sector of the opposite plate, which sector is in contact with brush; the sector in contact being free to dispose of its electricity while the charged sector is insulated, the result must be that the + E of the sector in contact will be dispelled through the brush, and − E be held bound. The sector in contact with brush must be about to enter the charging segment, and when it does so it becomes in turn insulated and retains its charge of − E. It passes on and effects a transient influence on such insulated sectors as it meets, until at its exit from the charging segment it in turn passes a sector in contact with a brush. This it in turns makes + and soon all the sectors of the charging segment become excited, and as they leave that segment they come charged into the discharging segments; but as only one plate leaves that charging segment at either side, only one plate at either side can be charged by it. We must have the other charging segment excited to produce a general effect. Now, how is the other charging segment excited? Mr. Walter's theory would explain, but the basis of that theory is taken away. It is clear that a sector cannot enter a charging segment without contact with a brush, and therefore cannot carry its charge beyond that brush; besides, the charge it would carry would be the wrong one, for, say the back plate comes down with − E, it is found to be + after passing the brush into the charging segment. How does this come about? Remember, no sector can get into a charging segment without being discharged. Let us examine the plates carefully with charged electroscope, stopping the machine and slowly setting it a-going. It will be found that if the machine be not self-exciting (its normal condition in my climate) and that we start the back plate at the top with a + charge, no sooner do the charge sectors come down near the brush of the lower charging segment, than the front plate, before neutral, shows + at its exit from that segment. Does not this clearly show that the + E of the down-coming back plate drives back the + E of the up-coming front plate? and thus raises the + of the front plate at its exit from the charging segment. But here a brush is found on the opposite plate. Let the driven back + E but induce the sector in contact with that brush, and the next moment the induced sector passes into the charging segment insulated and the fort is taken. One half revolution of a plate can do this.

Now the question arises, Has glass the capacity to have its electricity hunted to and fro over its surface without parting it to the air. It has, if smooth; but it does it slowly, and apparently with effort. Proof: Take two Leyden jar condensers; charge them to saturation for some time; take them in hand, and bring the outside foils together; then touch together the two brass balls connected with the inside. The jars discharge. Hold them together for a moment so that they may discharge thoroughly; then place them on the table or fender for half a minute. Try the same course with them again: they have recharged themselves, and will do so again and again if there is much glass uncovered. The explanation is easy. The foil-covered glass could not carry all the E sent to it. It spread over the uncovered glass, and when the foil-covered glass is emptied the E which was turned out comes back to the empty house; but remember it comes back slowly. This fact is material.

Now we have got all the sectors charged to the same potential as the initial charge, less waste—no more, and if the action stopped here this beautiful machine would never have been heard of; but the potential rises with surprising rapidity. How is this accounted for? A plate comes out of a charging segment carrying its feebly charged sectors, and in one revolution there is a blaze at the brush. It would take the aggregate electricities of all the sectors to make that blaze. Just so; that's what happens. The aggregate electricity is all driven together. The sectors no longer play a first part; they become valets, and help the plates to doff and don electrical garments at each brush, for the electricity is driven along glass and sector by the force of the hand which revolves the plates past each other in defiance of the similar electricities which don't wish to so pass. Any plate leaving a charging segment meets another plate coming in; both plates are similarly charged; what must happen? Each electricity drives back the other, and the potential of each rises, for the supply is ever coming on from behind. This only makes the resistance greater, for each charging segment is turning out a plate charged up to its own potential, and that potential rises as the electricity is driven back on it. What is the upshot? The glass plates drag a certain amount of E past each other to the rakes, where they only too gladly turn into side channels; or if the charging segment be too small—that is, if the brushes be too close—the E is driven back as far as the brush and escapes, when the potential falls in proportion to the escape, or if any aid, like a ring of moisture, assists the E to run along the plate faster than the plate travels, why the potential falls lower every moment, and the machine is reduced to its first puny induction efforts, which soon die out from leakage. All this may be tested by anyone making a machine without glass, or some such sluggish conductor, between the sectors. These may be placed on strips of glass set like spokes of a wheel. This machine will soon show how idle it was to ever suppose a little sector, with surface equal to a thimble, could by itself carry round one-third of the plate a static charge of electricity which would be anything but the merest moiety of what streams from it as it discharges the glass around it. "How is this?" says some electrician. "If sectors are mere collectors at this stage, and that rakes discharge them for one segment, why won't rakes discharge them for the other segment, and why need brushes?" Exactly so, sir; when the machine is in full excitement the brushes may be removed and rakes substituted. With these the machine works briskly. I only use the pointed wire carrying the brushes for this experiment. I can stop the machine to take off the brushes, and its potential will not fall too low to start the machine again. Of course, if the excitement is allowed to cool down to the puny sectorial induction stage, a rake distant half an inch cannnot neutralise a sector with the very feeblest little charge.

Mr. Wimshurst remarks that the tension seems higher near the brush, as the sparks are greater there. This is owing to the discharged sector offering a place to the high tension E, which is near it, and which leaps along the glass to the opened passage. The same thing can be seen if you cover your jars inside an inch or two higher than outside. This naked inch or two shows the E at every discharge leaping along its surface, because it can't go through the glass fast enough.

Mr. Wimshurst says, that with very many sectors the machine is more self-exciting. I have not tried this; but I accept this statement as indisputable, and I can understand that when sectors are needed to spread or collect a feeble charge over the glass, the more sectors to help, the quicker the work; but I shall be much surprised if the Leyden jars can show as high tension when the sectors are close enough to allow the glass to be dragged round, while the repelling electricities won't pass each other, but leap the spaces between the sectors like phosphorescent squirrels in their revolving cages. That much light in the dark would ensue, and little work with the jars I would suppose to be the result. I have not tried it.

In the foregoing I have spoken of glass as the material of the discs or plates, because glass was the material I used in my experiments; but I have noticed exactly the same properties in ebonite when experimenting some years ago with the Carrè machine.

LEGAL.

Otto v. Steel.—This case, one of great importance to those who have given attention to the manufacture of gas engines in this country, has been proceeding in the Chancery Division of the High Court of Justice for the last three weeks, and on Saturday Mr. Justice Pearson gave his decision, establishing the case of the plaintiff. This result, it will be remembered, is the reverse of that given in the French Courts some three months ago in the case of the Lenoir engine, which, as reported in the ELECTRICAL REVIEW at the time, was declared outside the Otto patents. The following summary of the case and report of the decision is taken from the *Times*:—

The action was brought by Dr. Otto, of Deutz, near Cologne, to restrain Mr. Robert Steel of Leeds, from infringing a patent granted to the plaintiff's agent in this country in the year 1876. The stakes are very large, and the action has been fought over 16 days with the greatest skill and pertinacity by counsel, who number among them men of the highest mathematical and scientific distinction, assisted as they were by expert witnesses of the greatest eminence in mechanics and physics.

For the plaintiff appeared the Attorney-General (Sir Richard Webster, Q.C.), Mr. Aston, Q.C., Mr. Hemming, Q.C., Mr. Davey, Q.C., and Mr. W. N. Lawson; for the defendant Mr. Moulton, Q.C., and Mr. J. C. Graham.

Sir Frederick Bramwell, Mr. Imray, and Prof. Dewar were the principal witnesses for the plaintiff; and, for the defendant, Dr. Hopkinson and Mr. Dugald Clerk, a theoretical and practical mechanician, the patentee of a gas engine known in this action as the Sterne engine.

The history of gas engines as illustrated only in this trial is like that probably of most inventions; it shows the result of the labours of a large number of minds in a succession of patents often ingenious and containing sometimes strange foreshadowing of future results, but which, nevertheless, from one cause or another, have generally proved abortive and in a few cases to have met with little success. The earliest patent before the Court was taken out by one Wright in 1833. That was followed in 1838 by Barrett's patent, which was intended to work with one of the advantages possessed by Dr. Otto's engine in the form he prefers, and the form in which certainly nearly all his engines have been constructed—that is to say, by exploding the gas under compression instead of as in the Lenoir and Hugon engines which preceded Dr. Otto's under atmospheric pressure, or something less. Dr. Otto himself had been working for years at producing an effective gas engine. In particular he took out a patent in this country about 10 years before his patent of 1876 for an engine which was used to some extent, and which has been called the shooter engine; he has also since 1876 patented some improvements. All these gas engines are worked, or intended to be worked, by means of an explosion of a mixture of gas and air taking place in a closed cylinder, by which means a large amount of heat is liberated and gives a great expansive power to the gaseous products of combustion and other gases not themselves chemically altered, such as the nitrogen of the air and any excess of air or dilution of the explosive mixture. The gases expanding

in this way act on a piston and drive the machine, just as hot steam drives a steam engine. Dr. Otto, in his specification, describes three plans for making an engine, the third of which is the preferable one, and we will again describe its main features. In the first place it is a single acting engine—that is to say, the explosive push takes place at one end of the cylinder only, pushing one side of the piston only, requiring, therefore, a heavy fly-wheel to take up the momentum and carry the machine not only over the dead points, but also for the whole of the in-stroke. In the second place this characteristic is exaggerated, because the engine is, so to speak, only a half-acting engine, for, in order to get compression in the manner he does, Dr. Otto has to sacrifice every alternate stroke and work with one explosion every alternate outside or every two revolutions of the fly-wheel, so that the fly-wheel has not only to carry the machine over a revolution and a-half, but in doing so to take up some of its momentum in compression. The machine thus works in a cycle of four operations, namely, two in-strokes and one out-stroke, the actual work done being the difference between the momentum taken in by the fly-wheel during the out-stroke when the explosion takes place in the fourth period of the cycle, as described below, and the momentum given out in the compression during the previous in-stroke, the third period of the cycle. The cylinder is of special construction, having a space at one end away from the fly-wheel which is never traversed by the piston, so that when the piston has arrived at the dead point after an in-stroke, there is a cavity in front of it of some three-eights of the whole of the internal space of the cylinder. To explain more clearly let us suppose the cycle to commence at that point of time when after an explosion the piston has arrived at the end of an out-stroke and is about to commence an in-stroke (the first period of our cycle of four periods); at that moment the cylinder is full of hot vapours or gases, called "residuum," partly steam and carbonic acid (the two products of so much of the gas as was explosive), partly the oxygen in excess of what was required for the complete combustion of the coal gas used, and partly hydrogen. By the valve arrangement of the machine a vent is opened at that moment, and during the in-stroke, the first period of the cycle, as much "residuum" as will go is let out, leaving only so much as fills at about atmospheric pressure the portion of the cylinder which is not traversed by the piston. During the first half of the second period, an out-stroke, air is let, or drawn in, by proper valve arrangement; and during the second half in a similar way an explosive mixture of gas and air is let in. At the end of the second period the full charge is in the cylinder. During the third period, an in-stroke, the machine is employed in bringing the piston head to the position in which it can be most effectively acted upon, and in compressing the charge; this, of course, using up a portion of the energy of the machine. The charge is then fired by a jet of ignited gas turned into the mixture at the point where the air and gas have been let in; combustion takes place at first very rapidly, and afterwards more feebly, so that near the beginning of the out-stroke, the last period of the cycle, an enormous push is exerted on the piston head, which diminishes, doing work all the time, till by the end of the stroke the pressure has fallen to about that of the air, and the next cycle is about to begin. That form of engine is constructed under Dr. Otto's third plan. He describes as his first plan a form of engine in which there is no compression, in which there is no residuum left in the cylinder, and in which ignition takes place every out-stroke; the air and explosive mixture being let in during the first half of the out-stroke and then fired, the work being done during the second half of the out-stroke, and without the thermo-dynamical advantage of compression. This form of engine differs from older gas engines in evidence in principle, in having some unexplosive air or gas let into the cylinder intentionally, in front of and separate from the explosive mixture. On this fact turned a great deal of the argument in the case. Dr. Otto's second form of engine, a compression engine, in which the gases are compressed outside the working cylinder, is not fully described in his specification. Mr. Clerk's engine, the Sterne engine which we shall have to refer to, is an engine in which compression takes place outside. Whether it comes within Dr. Otto's principle has not been decided, for the action raised to determine that question was compromised. Though Dr. Otto's specification is most skilfully drawn, and, considering the technical nature of the document, easy to read, it would be out of place to do more than to say that in the usual way it describes in the first place what he conceived to be the nature and principle of his invention, then it describes his machines by reference to drawings, in a way intended to give sufficient directions to enable a skilled workman, without further instruction, actually to make an engine; and, lastly, it contains a claim to the monopoly of four things—first, "admitting to the cylinder a mixture of combustible gas or vapour with air separate from a charge of air or incombustible gas, so that the development of heat and the expansion or increase of pressure produced by the combustion are rendered gradual substantially as and for the purposes herein set forth." The second thing claimed was the "cycle" of operations applicable to the third plan for an engine; the third thing claimed was the admission valve and governing arrangement; the fourth, the machine as described according to the third plan. The defendant admitted infringement. The last two claims were in no wise impeached. The second claim was impeached on the ground of alleged prior publication in England by the mere existence in the library of the British Museum of a copy of a treatise by a French engineer. That defence was dealt with in the course of the trial, and may be dismissed from consideration. The defendant's counsel also allowed that Dr. Otto had made a most valuable invention, but sought to invalidate the patent on the ground that the first claim was bad in that Dr. Otto, as was alleged, thought he had discovered that which did not exist. Even if the defendant could have invalidated the patent on the first claim, of course it would have been open to him to disclaim and still protect his engines under the narrower claims. Dr. Otto brought a former action on his patent of 1876—the action of "Otto v. Linford." The defendant got a judgment in the Court of First Instance, but on appeal the court decided in favour of Dr. Otto, and the present defendant sought to rest that judgment in his own favour by the interpretation his counsel put on the words of the Judges of Appeal, coupled with the fresh evidence on the scientific facts now adduced. Dr. Otto has also brought a third action of "Otto v. Sterne," the action referred to above, an action which was to have been heard together with this action, but was compromised. The contention of the defendant was that, according to the true construction of the first claim as explained by the body of the specification, the construction said to have been put upon the instrument by the Court of Appeal in "Otto v. Linford," Dr. Otto claimed to have between the explosive charge and the piston head what had been called a cushion of gases, impregnated with comparatively little combustible matter, which was said to have the effect of making the initial rise of pressure slower, and reduce the explosiveness and prolong combustion, whereas, according to the view of the defence, the mixture was comparatively homogeneous, rise of pressure rapid, and the explosion great compared to that in old engines; and, further, that even if there were any such heterogeneity of explosive powers over the inside of the cylinder a more rapid combustion would ensue on ignition than would be the case in a uniformly diluted mixture. It was asserted on his behalf that the admitted excellency of Dr. Otto's machine and the valuable results were due—first, to his working with compression, which produces great thermo-dynamical efficiency, and was aimed at by old inventors, especially a patentee of the name of Million, and to the great dilution the compression enabled him to use; secondly, certainty of ignition due in large measure to the application of the flame at the part near which strength in gas would lurk; and, in the third place, to his excellent mechanical details and workmanship. The plaintiff's counsel, on the other hand, contended that the true construction of the first claim was not that there was any material cushion between the piston head and the effective charge to act as a buffer in diminishing the great shock and prolonging the combustion, but that there really was in some way or other a shading-off of the strength of the explosiveness of the gases, so that the gas was certainly strong in combustibility in the region near ignition and weak elsewhere, and that the effect of this was, no doubt, to produce a rapid rise of pressure, which, however, was really sustained to a large extent by a prolonged burning, and that the enunciation of those facts was the fair interpretation of Dr. Otto's words.

Mr. Justice Pearson, in giving judgment, said he desired in the first place to thank, not only the counsel, but also the professional witnesses engaged, for the great assistance they had given him in supplying the Court with information that was required. He approached the decision, he said, with considerable diffidence, because he had to deal with difficult questions of science. He had to observe that the validity of this patent was in controversy in the prior action of "Otto v. Linford," which went to the Court of Appeal, and the validity was upheld. It was true that inasmuch as the defendant Steel was no party to that action the decision was not binding on him. But in so far as the construction of the specification was in issue, as a Judge of first instance he was bound by the decision of the Court of Appeal. He did not mean to say that in a case where the evidence before himself showed that the evidence given before the Court of Appeal was incorrect or insufficient he might not feel at liberty to depart from the decision of the Court of Appeal. Accordingly in this case, in respect of a certain objection against the validity of Dr. Otto's patent on the pure construction of the patent, that Dr. Otto had not specified the proportion of residuum to be left in, he was bound by the decision of the Court of Appeal by these obligations to state the proportion, but upon the matters actually raised before him for the most part he felt not fettered by anything in "Otto v. Linford," considering as he did that they were not raised in that case. His Lordship, after describing the Otto engine and its action, proceeded to say that the first objection raised, as he understood it, was that Dr. Otto by his first claim alleged that he had discovered how to place an incombustible mixture between the piston and the charge so as to alleviate the pressure and shock which would be produced if it were not there, and that there is not in fact anything like an incombustible mixture there. The next objection was that if the whole charge and residuum are taken together it is found that the mixture is heterogeneous, the claim was still quite wrong, because it says that the development of heat and the expansion or increase of pressure are rendered gradual, whereas it is said that what takes place is that there is a very rapid increase of pressure at first and afterwards not an increase of pressure but a decrease. His Lordship examined the explanation of the invention and the description of the machine contained in the body of the specification. Considering that the words employed by Dr. Otto were to be interpreted with reference to the whole document, he construed the meaning to be, not that there was an absolutely incombustible body of gas or cushion between the piston head and the explosive part of the charge, but that the combustible particles were more or less dispersed throughout the whole charge, being stronger near the place of

ignition; and also that Dr. Otto did not mean that actual pressure inside the cylinder was to be increased, as the charge burnt gradually, but that the decrease of pressure as the gas expanded and the piston did its work was to be lessened, and the pressure to some extent sustained by the more gradual development of heat that would take place in a uniform mixture. His Lordship then proceeded to analyse the evidence. It was very difficult, he said, to look inside a cylinder and see what took place there. He could only judge by such facts as were proved in evidence, and from them must come to the best conclusion he could. There were three sets of experiments to be considered. In the first place, there were the analyses by Professor Dewar. As far as he could judge that was the most satisfactory of all the experiments. Taking the three points at which the cylinder was tapped, the gas was of about the relative richness of 10, 7, and 5 per cent.—just about what might have been expected from Dr. Otto's specification. Sir Frederick Bramwell and Mr. Imray's experiments of a similar kind with the eudiometer corroborated this. His Lordship next referred to the experiments taken by Mr. Clerk with a platinum wire attached to the piston head, heated by an electric current, and the indicator diagrams taken from the Otto engine. These diagrams, his Lordship said, were so far from the normal diagram of the Otto machine, working under normal conditions, that he might put that experiment aside, except so far that it showed, if anything, that there was not homogeneity, but heterogeneity in the gases. Judging, therefore, as fairly as he could, he came to the conclusion that there really was heterogeneity. But Mr. Moulton had argued that if that were the case the plaintiff was merely using the residuum as a diluent, and that by putting in a stronger mixture behind the residuum he was reducing the strength of the whole mixture to that which was used in the Lenoir engine, and that the indicated diagrams showed that instead of there being a gradual increase of pressure in the cylinder during work there was great and rapid increase of pressure, and afterwards a decrease instead of an increase of pressure. His Lordship compared the indicator-diagrams in evidence, showing the change of pressure during the effective stroke in the Otto and Lenoir engines, explaining that the Otto diagrams showed that though the pressure was diminished during the stroke it was sustained and kept above the diabatic line—that is to say, it did not diminish so much as it would have done under the influence of an unsustained impulse or explosion, differing in that respect from the Lenoir engine. He came, he said, to the conclusion that there was heterogeneity in the Otto engine and that if the residuum were used as a diluent it was used under such different circumstances as to produce a different effect from diluents in the old engines. His Lordship then dealt with the question of anticipation, explaining that so far as the alleged anticipations were before the Court of Appeal in the case of "Otto *v.* Linford," he was bound by the decision there. He considered none of the patents or engines put in as anticipations to be anticipations of Dr. Otto's invention. He said that what struck him as more like Dr. Otto's invention than any other was Million's patent, but on considering the matter he thought the Attorney-General's argument was right, for Million did not intend to make use of the residuum in his "cartridge" in the manner that Dr. Otto did. He came to the conclusion on the whole case that in Dr. Otto's engines there was at the time of ignition a mixture heterogeneous and not homogeneous; that it had exactly the effect which Dr. Otto said it had in his first claim; and that there was no anticipation, and the patent was valid and good. That being so, an infringement was admitted. There must be the usual decree for an injunction, with the usual consequences.

Provincial Brush Electric Light and Power Company v. Shillingford and Bateman.—Mr. Justice Field gave judgment in this case, which was reported in our columns a fortnight ago, on Monday last. His Lordship said it was an action brought for £53 17s. 2d., the balance of a sum claimed as the price of an installation of the electric light for the defendants, who were brewers at Whitney. Although it was admitted that the work was done, and there was no question as to the reasonableness of the price, yet the defendant said he was not liable because the installation was not a success. The bill originally sent in was for £152 17s. 2d., but after the installation had been proceeding from September to December 18th, £100 was paid on account. The defendants, however, denied that they ought to pay anything at all, and claimed to recover the £100 as money paid under a mistake as to facts. The question was one of considerable difficulty, as it turned upon scientific questions on electric lighting, of which he knew nothing whatever except the little he had learnt, if it were learning, while the case was proceeding; and therefore, although it was necessary for him to explain the grounds upon which he had arrived at his decision, and to go slightly into the nature of the operation of an installation, yet he had little doubt he should do so inaccurately, at any rate as regarded professional terminology, although he hoped and believed he had made himself sufficiently master of the process to arrive at a right conclusion. Having explained pretty clearly and simply the manner in which the light is given by the filaments in the incandescent lamps, and the operation of the system used by the plaintiff company, including the use of accumulators to secure steadiness in the lighting, his Lordship continued: The motive power, a three-and-a-half horse-power steam engine, he pointed out, was on the premises previous to the installation, and used for general purposes. The installation was complete at the end of September. The contract was somewhat uncertain in its terms with regard to the number of lights that were to be put up, but there was evidence showing that it was intended to erect somewhere about 15, whereas, in point of fact, some 20 or 21 were actually put up. There was evidence that when the surplus number was being put up, the engineer of the plaintiffs said, "You may have the lamps if you like; but you must not run more than the number intended." The plaintiffs guaranteed that the light should be a success, but on the proviso that the installation was carried out under their personal supervision. Having erected the lights, the plaintiffs' people gave instructions to the engine driver, who was in the employ of the defendants, how to keep the installation going. He was to start the engine and run at a good speed; then turn on the switch and press the knob at the master cell; see the amount of current passing into the cells, and never allow the needle of the ampèremeter to show more than from 23 to 25 ampères. This was a very important part of the instructions, as it affected the whole working of the installation. Then, also, the batteries must never be charged whilst the lamps were lighting. The nature of these operations was one of some nicety, and one, he should think, that would require a man of more education in these things than an engine driver might be supposed to possess, although acquainted with all sorts of steam gauges and the working of his engine. During October, Mr. King, for the plaintiffs, went down and saw that everything was working well. After a time, however, the brushes on the dynamo gave way, although they were supposed to last three or four months; then the filaments in several of the lamps, which should have lasted 1,000 hours, broke. There was a good deal of discussion as to the cause of these things, and the plaintiffs said defendants were running whilst the lights were burning, and, with regard to the brushes, were pressing them too hard against the commutator, and thus destroying them. The plaintiffs sent down new filaments and supplied new brushes, and on October 16th defendants said everything was satisfactory. November came, and complaints were again made. Ultimately the plaintiffs, having furnished filaments and brushes, and always asserting that the error lay with the defendants' working and not in their own installation, applied for payment. The defendants seemed to be reasonably satisfied that the thing was right, and paid £100 on account; one of them was to call and settle a question with regard to some of the items in the account with the company's manager. He called, there was a discussion, but no further payment was made. Several applications for payment were made, but were not complied with, and ultimately the defendants ceased to use the electric light, and the plaintiffs brought this action. The question for him to decide was, which of the two parties was entitled to his verdict. The plaintiffs had undoubtedly done the work, and were entitled to the money as far as that was concerned; it remained, he thought, with the defendants to show that the work had not been a success. In one sense, undoubtedly it was not so, because defendants were obliged to pay for gas instead of having the electric light. But that did not conclude the question, because he had to see whether the defect was due to the installation or to the mode of running, for which the defendants were responsible. It was a question of considerable difficulty, and he had gone as carefully as he could into the matter, and he had been obliged to do what doctors did; that was, a disease existed, and there was a dispute as to the nature of it. The only mode of which he knew of finding out was to ascertain the symptoms. The symptoms here were principally three:—First of all, the filaments kept continually breaking. In the first instance plaintiffs said something must be wrong with the manufacture of them, and accordingly took great pains to have good filaments manufactured and sent down, and it was conceded that they were of the best manufacture. There was no complaint as to the wire, so that could not have caused the breakage of the filaments, and it seemed that they must have been broken from too much current passing into the lamps. Then, there ought to have been a vacuum in the lamps; but it was shown that the glass became clouded and obscured the light. Scientific gentlemen on both sides agreed that this might have been caused by too great energy being employed, causing the volatilisation of the filament, and creating a vapour which produced the effect on the glass of which complaint was made. The scientific witnesses for the defence said this might have been the case, but assigned a different cause; they said the machinery was never fit to carry 25 ampères. There was a complaint, besides, that the fuses broke. Again the symptom pointed to exactly the same cause—too much current. Besides this, there was the destruction of the brushes, and that also was assignable to the current being too strong. He had gone through these matters as well as he could, and had done his best to understand them, and he had come to the conclusion, upon the whole, that the defence was not successful. All the symptoms were consistent with there having been an over-running of the engine. Two of the witnesses asserted that this had not been the case, but he could not find that there was any defect to be imputed to the machinery, and that all the symptoms were the necessary consequence of the over-running, and he could not help thinking that, with the greatest desire to do what they ought, they did charge too highly. One matter of complaint was with regard to the accumulators, which were alleged to leak, and thus cause a great defect in the lighting. He could not, however, find that the leakage was of such extent as to cause any considerable difference. It was a matter of opinion, and in this case it was his duty, as far as he could, not to rest upon matters of opinion, but where he could see safe ground to depend upon admissions of fact, and in that way,

not forgetting that defendants paid £100 on account on December 15th, and after all the complaints were made, he thought they were too late in taking their present course, and that, upon the whole, the plaintiffs made out their case that, if there was a want of success, it was due to some other cause than any defect in the installation. Judgment, therefore, would be for the plaintiffs upon the counter-claim, and also upon the claim of £52 17s. 2d.

NOTES.

The Electric Light for Building by Night.—Messrs. Bradney and Company, of Wolverhampton, who are erecting a new theatre at Derby for Mr. Melville, of Birmingham, are about to adopt a novel expedient to secure the early completion of their work, states the *Mechanical World*. They have given an order to a local firm for the erection of four powerful electric lights, whereby the bricklayers and carpenters can proceed with their work by night as well as by day; some of the lights were erected last week, and several men worked under them. The power necessary for the lights is procured from the engine which grinds the mortar, and bricks warm from the kiln are used in building, so as to counteract the action of the frost. By this means a stoppage has not been necessary, even during the severe weather of the past week.

Bazaar Attractions.—At a bazaar held at Brentford, on the 16th and 17th December, in aid of the building funds of the British Schools, one of the rooms was illuminated by incandescent lamps, the power being obtained from E.P.S. accumulators. The work was carried out by Messrs. Nalder Bros., of Brent Electric Works, Brentford.

Towers of Strength. — The following concerning the electric light towers of Savannah is an interesting record of the permanent character American electrical engineers seem to think it necessary to give their light towers. The high electric light tower at the intersection of Liberty and Habersham Streets, says the *Savannah News* of November 16th, fell with a tremendous crash at six o'clock last night. The fall was caused by a runaway mule striking the tower. No one was hurt. The towers were put up about three years ago. They are anchored in a foundation of brick and cement, and were considered very strong. This tower is the third one that has fallen in Savannah. One at Huntingdon and Price Streets toppled over before it was finished. About a year ago a freight car in the Central Railroad yards jumped the track and crashed against the tower by the passenger shed, bringing it down. Two or three of the structures are 185 feet high. They are ascended by an automatic elevator, which, when not in use, is kept locked a few feet above the ground. Some months ago a painter who had been coating one of the towers got out of the elevator cage before fastening it. The cage at once started for the top, gaining in speed the higher it went. When it struck the top platform the whole top was broken off. Not long ago a tower in Macon was knocked down by a mule.

The Electric Light in Brighton.—The Brighton Electric Light Company has purchased the Brighton electric light business and plant connected therewith, lately the property of the Hammond Electric Light and Power Supply Company, Limited, and as the latter company had, in consequence of the increased demand for the electric light in Brighton, recently built new works of an extensive character, and laid down completely fresh machinery, the present company is in a position to accept a limited number of further orders for this now well-tried and perfected form of illumination. As the system has been at work in Brighton for four years, ample time has been available for perfecting it, and it can be seen in operation either at the Gloster Road works or in numerous places in the town.

The Proposed Telephone Exchange at Bath.—The Bath Town Council has adopted the following report of the Surveying Committee:—"The Western Counties and South Wales Telephone Company, being desirous of establishing an exchange in this city, applied for permission to fix the necessary posts and lines. After considering the application and inspecting the poles which it is proposed to fix and the wires to be used, and hearing the statement of Mr. Lewis, the secretary of the company, as to the probable advantages to accrue from the introduction of the undertaking, we recommend that the permission required be granted, subject to the details of the work being carried out to the satisfaction of your committee."

The Plymouth Telephone Exchange.—The shocking fire which lately occurred at Plymouth illustrates the great importance of more use being made of the Three Towns Exchange, which has its headquarters at Plymouth. Although the exchange has made considerable progress, it might well be more liberally supported, and then the company would see its way clear to concede to the public all-night communication, which would prove of such immense utility in case of fires. The history of the telephone in Plymouth is interesting. A Plymouth exchange was opened in August, 1881, by a company which was soon compelled to stop by the postal authorities on account of having no license. On the restrictions which hampered telephonic enterprise being somewhat modified by Prof. Fawcett, another exchange was opened at Plymouth on December 18th, 1884, by the same company, whose operations had previously been "nipped in the bud"—the United Telephone Company. In April of the present year the Western Counties and South Wales Telephone Company purchased the business of the old company, and since then has been striving hard to obtain a more liberal measure of public support; but it has been heavily handicapped by the postal authorities. The policy of the newly-formed company is to endeavour to obtain on its list of subscribers those who are at present bound to remain on the Post Office Exchange for a given time. To this end, it has offered to place on the list, free of charge, the subscribers to the Post Office until their term of agreement expires, on the condition that for three years afterwards they become ordinary paying subscribers. There are now 95 subscribers to the Three Towns Exchange, and it is promised by the company that when this number has been increased to 200 it will concede all-night communication, without making any extra charge. It also promises that should the Government remit the ten per cent. tax which is at present made on the rentals, the customers shall receive the benefit of the remisssion. Considering the excellent spirit exhibited by the company, success ought to crown its efforts, and to everyone interested in the maintenance of private enterprise this end will be regarded as "a consummation devoutly to be wished."

Charges for Telegrams.—At a meeting of the Southampton Chamber of Commerce last week, a resolution was moved by the hon. secretary to the effect:—"That it is desirable that the registration fee of one guinea for telegraphic addresses should be reduced to a nominal fee." He suggested a fee of 5s. for a name and 10s. for a cypher. The motion was adopted.

Electric Lighting at Taunton.—The town of Taunton is now partly lighted by electricity. Five arc lights have been erected around the Parade, and twelve tradesmen in the principal streets have the light in front of their shops. The current is generated by means of a nine horse-power steam engine, situated under one of the arcades of the Market House. Mr. Massingham, of Bath and Taunton, has introduced this desirable innovation, and if the present trials prove satisfactory, the electric light will be permanently adopted for public lighting.

A Postal-Telegraph Office on Fire.—On Wednesday evening, last week, Mr. A. Cundy, telegraphist at the Truro Post Office, discovered that the room in which he was engaged was in flames. The fire brigade was immediately communicated with, and the application of a hose soon extinguished the fire, which caused but trifling damage.

A Curious Disconnection.—Sapper W. Davis, R.E., gives the following account, in the *Military Telegraph Bulletin*, of a disconnection which occurred in a line of which he had charge :—"For some weeks past a fault has been existing on a wire running from Newton, Moreton, Bovey, and Chagford, which has caused considerable trouble. The wire was continually being disconnected between Newton and Chagford, and every effort was made to find the fault, but without success. At times it would be all right, and at others all wrong. While I was at Bovey, watching the wire in hope of finding the fault, the postmistress opened a drawer close to the instrument, and I noticed that the circuit came right while the drawer was open, and the circuit went 'dis' after it was shut. I tested, and found that the fault was close at hand, and at last succeeded in finding it out. The explanation is this : The line had run behind the drawer, and had got broken inside the G. P. When the drawer was opened, it pulled the wire tight and joined the broken parts together inside the G. P., and made contact, then circuit was working all right ; when the drawer was closed, it bent the G. P. double, and disconnected the broken parts again."

New Cable Ship.—The cable steamer *Mirror*, which is intended for the service of the Eastern Telegraph Company, was successfully launched from Messrs. Napier's shipbuilding yard at Glasgow on Monday. Sir James Anderson, in the course of some remarks, said the company had sent messages to America in 4 min., to Australia in 10 min., and had once got a reply from India in 5 min.

The Electric Burglar Alarm Acts.—The man who unlawfully broke into 28, Little Windmill Street, on the night of the 19th November did not calculate upon having to contend with electricity, and so did not use sufficient caution to prevent the operation of an electric alarm bell, which informed a policeman, who happened to be on adjoining premises, that something unusual was occurring, and led to the burglar's arrest. Unfortunately, however, the constable was attacked by confederates of his prisoner, who eventually escaped from his custody.

The Bambouxera Again.—This excellent fantasy of one of our friends, has made the round of the press, and it has come back to us to-day, but changed in a way which renders it still more amusing. The following is the version in *La Lumière Electrique*, which gravely announces the news without any reserve :—"It is known that the carbon filament of incandescence lamps is obtained by calcining in a vacuum filaments of Japanese bamboo. What is less well known is, that this plant conceals in its fibres an insect which after having chosen its habitation, remains there alive in spite of the carbonisation in the vacuum. It is to the presence of this insect, called the *bambouxera*, that the short duration of the carbon filaments of certain incandescence lamps is due."

We hope, says *L'Electricien*, that *La Lumière Electrique* will announce with less assurance, and above all, with less confidence, the apparition of the *microbus laboris vastator*, another infintely little one, which, in the transmissions to great distances, attacks the work transmitted per unit of time, whilst it respects the rendering.

This respect is explained, moreover, by the fact that the rendering being a "*rapport*," its dimensions are *zero*, which renders the attack difficult even for a microbe.

The Blackpool Electrical Tramway.—We learn that there are now three of Mr. Holroyd Smith's cars in daily operation on this line, and that the managing director of the company finds from actual experience electrical propulsion to be much cheaper than horses for the purpose.

The Late Sir William Siemens.—A biography of this eminent man is being prepared at the desire of the executors by Dr. William Pole, F.R.S., Honorary Secretary of the Institution of Civil Engineers, and author of the Life of Sir William Fairbairn, Bart. Dr. Pole will be grateful for the loan of any of Sir William's letters or for any information of importance. Address, Athenæum Club, S.W.

The Creil Tests.—It appears that everything did not run smoothly on the day of the official tests before the Academy of Science on the 5th December last, but extenuating circumstances are pleaded. Besides, whilst waiting for the official documents, the account given by a trustworthy and friendly paper, *Le Temps*, is enough to fully justify our notes and criticisms. The chief incident which occurred during the course of the interesting tests made by M. Marcel Deprez before the Academy of Science is known. There was a sort of "shock" returning towards the generating machine ; at a certain period the current coming from Creil spent itself in causing enormous green sparks to flash, which destroyed some of the small instruments. M. Sartiaux, chief engineer of the Northern Railway Company of France, occupied himself in making a minute enquiry into the cause of this phenomenon. He published the results of this enquiry in a letter which M. Bertrand read before the Academy. It follows from the investigations of M. Sartiaux that, in two places on the telegraph line, some wires which ought to have been insulated, had been placed in connection. But how ? Was it by the wind, by a branch of a tree being blown backwards and forwards, or by malevolence ? It was not possible to tell with certainty. Whatever may have been the cause, M. Sartiaux concludes by saying that the fault in the insulation which had nullified the test is an easy matter to overcome, and that the accident did not radically affect the test.

M. Bertrand analyses a note of M. Marcel Deprez, giving an account of the general method of the new arrangements which he had undertaken for the trials in which he was engaged. It was thought that the potential of 3,000 volts was too great for the machines ; but, thanks to the perfection which had been obtained by rings of different construction to those of the Gramme machine, M. Deprez obtained results more satisfactory and certain, so that it would probably be possible to reach or exceed a potential of 7,000 volts. These rings had not been made in a sufficiently large number for the experiments which took place before the Academie. To sum up, adds M. Bertrand, success is certain, the result has been achieved ; the transmission of power with a rendering of about 40 per cent. is accomplished. Only, says *L'Electricien*, there is rather too great a hurry to make us witnesses of the affair, and the inventor does not take sufficient care to guard against a description of accidents which tend to shake our confidence.

Gas Engine Patents.—As the gas engine plays such an important part in many an electric lighting installation, we have thought the judgment in the case of "Otto *v.* Steel" of sufficient importance to bring fully before our readers in this, the last number of the present year.

Electricity in Warfare.—In our present issue we bring to a conclusion Lieut. Fiske's interesting and instructive lecture on "Electricity in Warfare," delivered barely six weeks ago before the Franklin Institute of America.

Glasgow New Fire Alarm System.—A sub-committee of the Glasgow Town Council has been engaged lately in considering how best to render the fire alarms more efficient. Considerable difficulty had been experienced in the up-keep of the old method, especially with the batteries, which were many, a separate set of six being fixed in each signal box over the city. A number of systems were examined at home, and visits made to distant places, resulting at last in the selection of a simple plan, the invention of Mr. Munro, of the firm of Messrs. Anderson and Munro, electrical engineers, Bothwell Street, Glasgow. Briefly described, Mr. Munro's plan is to work all the outside signal boxes from one central battery—some ten cells only—having direct wires to each. At the signal box a plunger puts the line to earth, and so causes a powerful bell to ring, both at the box and the central station. In addition, an indicator falls at the central and announces the locality whence the alarm comes. The attendant, or fireman on duty, by disconnecting the line causes both bells to cease ringing. The system is sparing of battery power, as also of line wire; but it is open to the serious objection of possibly giving a false alarm by the wire being accidentally put to earth. To obviate that as far as possible, the overhead wires have been carefully covered with good insulating material, and there is also ready to hand means of rapidly testing the line should the genuineness of any signal be doubted. At the public alarm box there is a locking arrangement, whereby the plunger is kept fast till the box is opened by the firemen and again set for work. A Morse key is permanently affixed thereto, and a telephone can also be used, if such communication is found necessary. There are nearly 100 alarm boxes—96 in all—in the city and outskirts, and the patentees have contracted to maintain the system for the next seven years, together with the telegraphic communication connecting the various stations of the fire brigade—some 70 miles of line—all overhead.

Electricity and Gunnery.—Mr. Maxim, the inventor of the automatic machine-gun, having suggested a novel application of electricity to the training of heavy ordnance, trials have recently been made at Shoeburyness with a 43-ton gun with satisfactory results. The system is said to be so simple that every movement is completely under the control of one individual. The experiments are in charge of Mr. W. H. Massey, who states it as his opinion that ten or more guns could, if required, be laid either singly or in groups by means of a single lever worked at some distance from the guns. It is expected that a combination of the electrical gear with a Maxim disappearing platform, designed for working the heaviest guns without the use of complicated machinery, will be tried shortly.

Electric Tramcars.—The *Berlin Börsen Courrier*, of December 16th, in speaking of Reckenzaun's tramcar, says:—"All trials made have been exceedingly favourable to the new system, and the hope is entertained that the Berlin Tramway Company will adopt the system of electric cars, at least on some of its routes. It is probably in consequence of this prospect that a very brisk business was done on the Bourse to-day in the shares of the company, and that they advanced 1 per cent."

Technical Education.—The Clothworkers' Company has raised its annual subscription to the City and Guilds of London Institute from £3,000 to £4,000, subject to the precedent condition of the Corporation and Associated Livery Companies raising the total of their annual subscriptions to the institute from £24,500, the present amount, to £30,000. The capital expenditure in the building and equipment of the Central Institution, Exhibition Road, the Finsbury Technical College, and the South London School of Technical Art, has been nearly £140,000.

Forgery and Fraud by an Electrician.—Charles Stuart Cochrane, 30, an electrician, and Caroline Fanshawe were charged on remand before Alderman Sir R. Carden, at the Mansion House, on Monday, with forging and uttering the certificates of transfer of fourteen shares in the Artisans', Labourers', and General Dwellings Company, Limited, of the value of £1,160, and with personating Mr. Chas. William Foghill and Miss Letitia Mary Napier, in whose names the shares stood as trustees for the prisoner Cochrane's wife. The male prisoner, who was passing under the name of Franklin, took all the blame on himself, and exonerated the woman. He gave up to the police £847 in notes and coin, a large quantity of American dollars, and a quantity of jewellery. The shares had been deposited, with some papers belonging to the male prisoner, at a bank, and access was obtained in that way. Further evidence in support of the charge was given, and eventually the case was again adjourned, the woman being admitted to bail.

A Light and Power Installation.—A friend recently visited the premises of Messrs. Hunter and McMorran, Ironmongers and Seedsmen, Lanark, Scotland, where Mr. David Hunter has had a small installation of electric lights successfully running since September, 1884. For motive power he purchased one of Tangye's vertical 2 H.P. nominal steam engines, with boiler combined. It is fitted with two pulleys some 4 ft. in diameter, and with 43 lbs. of steam runs at 170 revolutions per minute, driving an A Gramme dynamo at 700. With the current thus generated 16 20 candle-power Swan lamps are lit; and an additional 10 for occasional use are also connected up. There is, besides, one of Andrews's arc lamps in the shop, which can from the switchboard be immediately exchanged for 10 incandescents fixed in coloured reflectors in the ceiling. The oil, store and powder rooms are lit from the loft above, and here, especially, the question of safety is most apparent. In the seed house, the previously heavy and tedious hand labour work of sifting and cleaning rye seed is accomplished by means of the electric current. A second small Gramme dynamo is driven as a motor by the machine which at night feeds the lamps. For two months this year the motor has been at work daily from 10 a.m. to 3 p.m., and has done its work far more rapidly and efficiently than was ever done by hand.

Engineering Examinations at Cambridge.—The special board for physics and chemistry at Cambridge have reported that they are of opinion that in consideration of the number of members of the University engaged in the study of engineering, it is desirable to provide for such students an honour examination by which their proficiency may be properly tested. The board have had under their consideration a scheme for an examination, and have submitted proposals defining the general lines upon which such an examination should be arranged. The first of these proposals is that, as an alternative to the first part of the examination for the National Science Tripos, there should be established an examination in which there should be set papers which should contain questions in mathematics and the elements of physics and chemistry. The report is signed by Professors Liveing, Hughes, Stuart, Dewar, Lewis, and Thomson, Mr. Trotter (Trinity), Mr. Glazebrook (Trinity), Mr. W. N. Shaw (Emmanuel), Mr. W. J. Sell (Christ's), and Mr. Pattison Muir (Gonville and Caius).

Electric Light at Leadenhall Market.—The old portion of Leadenhall Market, of which Messrs. Geo. F. Brooke & Co. are the proprietors, is being lighted during the present Christmas show of poultry by six arc lamps and a number of incandescents. A Goolden and Trotter dynamo is used, driven by a 12 H.P. gas engine, which at other times is used by the firm for its refrigerating process. The electric lighting has been successfully carried out by Messrs. Craven and Elworthy.

The Brockie-Pell Patent "Universal" Arc Lamp.—With reference to the stated remarkable steadiness of this lamp, we observe that as a proof of this the result of an experiment, which was recently made in the presence of a high Government official, is quoted. It is said that "a very delicate Thomson mirror galvanometer was placed in a shunt circuit across the arc whilst the lamp was burning, and the variation in the range of the spot of light on the scale did not exceed 10 divisions in 300." Now, as a matter of fact, "10 divisions in 300" is as much as 3·3 per cent., and we hardly see how such an amount of variation in the electromotive force between the terminals can be, as it evidently is, regarded as exceedingly small.

Maxim-Weston Electric Company.—Writing in a financial contemporary, "An Old Shareholder" of this Company says: "I am pleased to see that, at last, the shares of this company are attracting some attention, which I am much surprised they have not received before, considering the many favourable facts which, I believe, are well known. I understand that, whatever party may be in power in the spring, it is quite decided to materially modify the last Electric Lighting Act, which so utterly crushed the hopes that had been raised that this beautiful and desirable means of lighting was at once to be largely adopted, and which public opinion will insist on before long, and that it is to be replaced by an Act which shall do all that Acts of Parliament can reasonably do to encourage this long-hoped-for desideratum. I believe that this company is undoubtedly doing a considerable amount of good, profitable business, with prospects, almost amounting to certainty, of a great deal more shortly, with happily ample resources for carrying all out. Considering that for the year 1884 this company earned a fair dividend, the result of this year's work is certainly better than last, and with the prospect of shortly opening up the illimitable field that public lighting would be, surely the present quotation of 7s. 6d. is not a fair valuation for these shares, and would not double the price be nearer the mark?"

Illuminating Mills by Electricity. — Messrs. Harrison & Co.'s mill, Port Adelaide, is the first in South Australia to be lit up at night by electricity. The Australian Light, Power and Storage Company, of Sydney, has taken a contract for lighting the mill. The dynamo used is a "Victoria" Brush, and is capable of supplying a current for 40 Swan lamps of an electromotive force of 53 volts. At present there are 25 lamps actually in use in the mill. The cost of working the machine will be purely nominal to Messrs. Harrison and Co., because the motive power, which is already supplied by the mill, is about the most expensive item usually. Altogether it is expected that the electric light will prove 30 to 40 per cent. cheaper than gas in the mill. In some of the Victorian mines the saving thereby has been as much as 50 per cent. Though this is the first mill lit by electricity in the colony, several have been lit in the other colonies. The most notable in New Zealand recently is reported to be a marked success. Mr. E. M. Grant, the engineer for the lighting company, is also engaged in putting up an installation at the Albion Mill, Gawler, which will be lit by electricity by about the middle of next week. The work at Messrs. Harrison & Co.'s mill was rapidly executed, and on the first trial every light gave satisfaction.

The Bell Telephone Patents.—Exchanges of the 12th instant expected that the decision of the Secretary of the Interior, in the telephone case, would be rendered within a day or two. The opinions of the Commissioner of Patents and of the two Assistant Secretaries had already been prepared and handed to the Secretary. It was stated that they all agreed in recommending that the validity of the Bell telephone patents be tested in the Courts. This was expected to be the decision of the Secretary of the Interior also.

The Drawbaugh Telephone Case.—Judge Wallace has given his decision on the renewed hearing of this case, concluding as follows:—"The legitimate effect of the evidence is to show that Drawbaugh was very near the realisation of the invention if he had really constructed instruments like the exhibits F, B and C prior to the date of Bell's patent. It does not, however, alter the fact that he was unable to make such instruments at a period long subsequent to the time when he claims to have made them; and, in view of this fact, the evidence does not tend to materially fortify the testimony of the witnesses who think, or profess to think, that they heard or saw efficient practical instruments in operation at Drawbaugh's shop on the occasions to which they refer. The conclusions that were reached at the former hearing have not been modified, and the decree ordered should not be disturbed."

The Meucci Telephone Claims.—Suit has been brought by the American Bell Telephone Company against the Globe Telephone Company, and also against Mr. Meucci personally. As Meucci is over 80 years of age, the defendants are anxious to preserve his testimony, and have asked that it be taken at once, and this is now being done.

The Telephone Question.—Mr. E. Berliner, writing to the *Scientific American* on "the other side of the telephone question," says:—"The method of producing undulations by immersing an electrode in liquid, which is the subject of Mr. Gray's caveat, was described in Mr. Bell's original application, which was sworn to several weeks before Mr. Gray's caveat was *written*. Hence, it is absurd to assert that Mr. Bell obtained that idea from Mr. Gray's caveat."

Telegraph Insurance.—The sixpenny telegram would not appear to be an unmitigated blessing to the commercial men of Glasgow, if we are to judge from the correspondence column of the *Glasgow Herald*. Refering to errors in transmission, "Justitia" writes:—"We have frequently had to complain to the telegraph authorities on this point, without apparent result; and since the introduction of the cheap rate for telegrams the evil has gone from bad to worse. It is poor satisfaction to receive a stereotyped reply, couched in apologetic language, for such errors; and we think that a system of insurance might with much benefit be adopted, whereby any loss through carelessness would have to be borne by those at fault. In fairness this should be so, as it is most unreasonable and a very one-sided bargain to insist on payment without a guarantee that value will be given or acceptance of liability for error. By making an optional charge for insurance this evil could to some extent be remedied. It would add to the telegraphic revenue, it would fix liability in the proper quarter, it would be the means of forcing greater care on the part of the telegraphic employés, while it is a charge that many senders of messages would willingly pay to avoid the risk of error."

Science in Parliament.—The Right Hon. J. H. A. Macdonald, Q.C., Lord-Advocate of Scotland, who has been returned to represent the Universities of Edinburgh and St. Andrews, is an associate of the Society of Telegraph Engineers, is the inventor of the "Holophote Course Indicator," for the prevention of collisions at sea, for which several medals and certificates of excellence have been conferred, and is the author of works on law, education, and military tactics. In 1884 the university of his native city conferred upon him the degree of LL.D., and when the Conservatives came into office he was appointed Lord-Advocate of Scotland.

Electric Lighting of Ships.—The Wallasey Local Board invites tenders for fitting up the electric light on six of its passenger steamers. Sealed tenders, addressed to the Chairman of the Ferry Committee, and endorsed "Tender for Electric Light," to be sent to Mr. T. Somerville Jones, Public Offices, Egremont, Cheshire, by 5 p.m. on the 31st inst.

Against the Laws of "Nature."—In the REVIEW for December 5th, we ventured to remark that Mr. Bottomley's results on the measurement of temperature would not escape criticism. His paper, originally published in *Nature*, was reproduced in our columns of the above date, and in connection therewith we have received the letter given below :—"Directly after the appearance in *Nature* of Mr. J. T. Bottomley's paper on 'Radiation of heat from the same surface at different temperatures,' I sent the editor of that periodical a letter correcting the assumptions of Mr. J. T. B. After receiving a 'proof' for correction for press, and noticing, after many days, its non-appearance, I received in reply to my enquiry on the subject that the editor could not print a letter 'so offensive in tone.' As you have inserted the original paper in your pages, I send you, not the same letter, as I do not wish to offend more weak brethren by my righteous indignation, but merely the results as they should be without any further comment; but that the temperatures are *calculated* from the electrical resistance of the wire, and not *estimated* by its superficial appearance.

Case.	Absolute temperature.		Energy emitted.	Ratio $\frac{e}{e^1}$	Ratio $\frac{S^4 - T^4}{S_1^4 - T^4}$	Ratio $\frac{B}{A}$
	of wire.	of surroundings.				
	(S)	(T)	(e)	(A)	(B)	
1	298°	288°	1·078	1	1	1
2	386°		6·636	6·1	15·14	2·48
3	649°		78·12	71·9	168·3	2·34
4	701°		98 0	90·2	231·6	2·57

Rejecting Case 1 where the difference in temperature is very small, Stefan's law is remarkably confirmed as the final column testifies.—F. J."

Important Decision *re* Electric Lighting.—The judgment delivered by Mr. Justice Field in the case of The Provincial Brush Electric Light Company *v.* Shillingford and Bateman, is fully reported in our other columns. We think that the ruling of the judge, under the circumstances, could not have been otherwise, although we are equally inclined to the belief that the installation might have been of a more satisfactory nature. The details of evidence connected with the case will well repay perusal, and the decision is of moment both to consumers of, and contractors for, the electric light. The moral is plainly this, that the former class should avail themselves of technical assistance.

"Primary" and "Secondary" Batteries.—The following has been sent to us, too late, however, for our Correspondence columns :—Will you allow me to suggest in your columns a definition of primary and secondary batteries that is based on a real distinction, viz. :—that a primary battery is one in which the two plates consist of two different materials, and that a secondary battery is one in which the the plates are initially identical. This is a definition that is not ambiguous, and that will not admit of the same battery being at one time "primary" and at another "secondary." Under the present definition this may repeatedly occur. Thus, if you have a battery composed of plates that require to be re-made after it has been run down, and the re-made plates have to be charged, then you have what is now defined as a primary battery. Suppose you perfect this battery, and can then re-charge without re-making, then the same battery becomes a secondary. The change of name is here determined by a mere accident of manufacture, not by a real difference of nature. The definition I propose would entirely remove all such discrepancies.—J. G. S.

Ball-Room Lighting.—Mr. E. Storey, of Oundle, upon the occasion of the coming of age of his son gave a dance on Tuesday, the 15th inst. Lane-Fox lamps of 40 candle-power, 40 in number, were used to light the pavilion erected for the purpose, when the coolness of the atmosphere was enjoyed by everyone.

NEW COMPANY REGISTERED.

Brighton Electric Light Company, Limited.—Capital £25,000 in £5 shares. Objects : To acquire the electric light works at Brighton recently carried on by the Hammond Electric Light Company, Limited. Signatories (with one share each)—*Robt. Hammond, F. H. Bentley and A. F. Hodgson, 117, Bishopsgate Street Within ; *W. Smithett, 37, Vernon Terrace, Brighton ; *W. Collins, Oliver Grove, South Norwood ; J. B. Jordan, 67, Ivanhoe Road, Camberwell ; E. Brooman, jun., 10, Rockmead Road, South Hackney ; H. St. John Winkworth, Egham. The signatories denoted by an asterisk, and Mr. Arthur Wright, are the first directors, qualification 10 shares. The remuneration of the board will be such amount as may be voted by the company in general meeting. Registered 16th inst. by Messrs. Nye, Greenwood and Moreton, 12, Serjeant's Inn, Fleet Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Callender's Bitumen, Telegraph and Waterproof Company, Limited.—The annual return of this company made up to the 2nd ult., was filed on the 6th ult. The nominal capital is £40,000 in £10 shares, the whole of which have been subscribed. £10,000 has been received in payment of calls, 3,000 shares being considered as paid up.

Edison's Indian and Colonial Electric Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 28th ult., and filed on the 15th inst., sanctions the reduction of the capital of the company in accordance with the resolution passed at an extraordinary meeting of the company held on the 28th of May, 1884, and confirmed on the 13th of June, 1884. The registered nominal capital is now £117,500 divided into 45,000 A shares of £2 10s. each and 5,000 B shares of £1 each. The company is also empowered by the order to omit the word "reduced" from its title forthwith.

Railway and Domestic Electric Lighting Company, Limited.—The annual return of this company made up to the 18th of October, was filed on the 19th inst. The nominal capital is £6,000 in £10 shares, the whole of which have been taken up. £5 per share has been called and paid upon 240 shares, the remaining 360 shares being allotted to the vendor, credited as fully paid up. As compared with the previous return the paid-up capital exhibits an increase of £50.

Blackpool Electric Tramway Company, Limited.—The annual return of this company made up to the 12th inst., was filed on the 19th inst. The nominal capital is £3,000 in £10 shares. 2,850 shares have been taken up and £5 per share has been called. The calls paid amount to £14,242, leaving £8 unpaid. As compared with the previous return, the paid-up capital shows an increase of £340.

Volta Electrical Company, Limited.—At an extraordinary general meeting of this company, held on the 7th inst. at 2, Chatham Buildings, Circus Street, Piccadilly, Manchester, it was proved to the satisfaction of the meeting that the company by reason of its liabilities, cannot continue its business, and it was resolved to wind up voluntarily, and Messrs. Walter T. Glover and T. Browett were appointed liquidators, with power to expend money for the purpose of carrying out existing contracts. These resolutions were duly registered on the 16th inst.

Brighton Electric Light Company, Limited.—An agreement dated 1st inst., and filed on the 16th inst., between Robert Hammond of one part and F. W. Bentley (for this company) of the other part, provides for the sale to the company of the leasehold premises, plant, &c., at Brighton, acquired by the vendor from the liquidator of the Hammond Electric Light and Power Supply Company, Limited. The consideration is 1,600 shares credited with £3 15s. as paid up each, leaving a liability of £1 5s. per share.

CITY NOTES, REPORTS, MEETINGS, &c.

Mediterranean Extension Telegraph Company, Limited.

A GENERAL meeting of this company was held on Monday at the Cannon Street Hotel, having been convened by the liquidators, the Hon. Ashley Ponsonby and Mr. John Griffiths, in order that the shareholders might receive an account showing the manner in which the liquidation proceedings had been conducted and the property of the company disposed of, and fix the liquidators' remuneration. Mr. Ponsonby presided.

The Chairman stated that there was an item in the accounts of £330, representing unclaimed dividends. In the ordinary course of events that sum would belong to the shareholders, but the company being in liquidation they would have to take the decision of the Court respecting it. The balance they had to deal with was £1,739, out of which it was proposed to return another 1s. 2d. per share. That distribution would absorb £886, and it was suggested that the balance of £853 should be given to the liquidators, out of which they would, if the proposal were agreed to, pay as compensation £250 to Mr. J. de Normann and £100 to Mr. J. W. Atmore, former officials of the company. He did not think the amount which the liquidators asked for could be regarded as too much, seeing that they had been two years at work. It might be asked how it was that they had been so long. Almost immediately after the resolution to wind up the company was arrived at the Italian Government gave them notice that they had no power to sell the concessions held from that Government, who, however, offered to assist them in the matter. A Bill was accordingly introduced into the Italian Houses of Parliament authorising the liquidators to make over the cables and concessions to the Eastern Company, but that took rather more than a year to accomplish. Then they received notice of the action which was about to be commenced between the preference and the ordinary shareholders of the company. Although the liquidators had nothing directly to do with that action it had given them a good deal of work, and the last they had to do with it was in regard to the taxed costs, which were not delivered until last August. After that a whole month's notice had to be given in the *Gazette*. At the same time the shareholders had not been kept out of their money, for they had already been paid £3 5s. a share.

Mr. Wells expressed his gratification at the result of the liquidation, and proposed a resolution approving the accounts.

Mr. Clout seconded the resolution, which was carried unanimously, as was also a resolution recommending the liquidators to declare a final dividend of 1s. 2d. a share on the preference and ordinary shares.

Mr. T. Adams moved, and Mr. Lean seconded a resolution, fixing the remuneration of the liquidators at £853, "the liquidators undertaking to pay and satisfy any outstanding claims on the part of the late officials of the company," and this was passed.

Mr. Griffiths stated that there would be one more meeting to wind up the company finally, but that would not be held until the decision of the Court had been given respecting the unclaimed dividends.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The coupons on the five per cent. Australian Government Subsidy Debentures, due on January 1st, will be paid on and after that date at the office of Messrs. Barclay, Bevan and Co., 54, Lombard Street, E.C.

Great Northern Telegraph Company, Limited.—The half-yearly interim dividend on the shares of this company, at the rate of 5 per cent. per annum, will be paid on January 1st by Messrs. C. I. Hambro & Son, at their offices, 70, Old Broad Street, E.C.

The West Coast of America Telegraph Company, Limited.—The coupons due on the 31st inst. on the debentures of this company will be paid by Messrs. Barclay, Bevan & Co. The coupons must be left three clear days for examination.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 18th were £2,619, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th December are £2,438, as compared with £2,260 in the corresponding period of 1884.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended December 18th were £3,395.

PROCEEDINGS OF SOCIETIES.

Physical Society, December 12th, 1885.

Prof. GUTHRIE, President, in the Chair.

Mr. C. F. Casella and Prof. T. E. Thorpe were elected members of the Society.

The following papers were read: "On a Magneto-electric Phenomenon," by Mr. G. H. WYATT. The author had conducted a series of experiments with a view of testing experimentally an expression obtained by Mr. Boys for the throw of a copper disc suspended by a torsion fibre between the poles of an electromagnet when the current was made or broken, and communicated by him to the Society on June 28th, 1884. Discs of various metals and of various dimensions were used, the results being such as to agree with the theory within narrow limits. It was, however, found that when the throw of the disc was used to measure the magnetic-field, the value obtained from the throw at break was uniformly greater than that obtained on making the current.

Prof. S. P. THOMPSON observed that the case presented was analagous to that of the ballistic galvanometer, and that for the theory it was necessary that the magnetic-field should be made and destroyed before the disc had moved sensibly. Mr. Boys believed that the results of the experiments showed this to be the case, since the result of such a movement would be to increase the throw on breaking the current, when the disc made an angle of less than 45° with the lines of force, and to decrease it when the angle was between 45° and 90°; whereas no such variation from the theoretical result was observed.

"On some Thermo-dynamical Relations," by Prof. WILLIAM RAMSAY and Dr. SYDNEY YOUNG. In this paper experimental proof is given of the following relations: (1) The amount of heat required to produce unit increase of volume in the passage from the liquid to the gaseous state, at the boiling point under normal pressure, is approximately constant for all bodies. (2) If these amounts of heat be compared at different pressures, for any two bodies, then the ratio of the amount at the boiling point under a pressure, p_1, to the amount at another pressure, p_2, is approximately constant. (3) The products of the absolute temperature into the rate of increase of pressure with rise of temperature are approximately the same for all stable substances. (4) The rate of increase of this product with rise of pressure is nearly the same for all stable substances. (5) A relation exists between the absolute temperatures of all bodies, solid or liquid, stable or dissociable, which may be expressed in the case of any two bodies by the equation

$$\frac{T_A}{T_B} = \frac{T_A'}{T_B'} + c\,(T_A' - T_A)$$

T_A and T_B being the absolute temperatures of the two bodies corresponding to any vapour pressure; T_A' and T_B', absolute temperatures at any other pressure, and c a constant which may be zero or a small positive or negative quantity. (6) The variations from constancy of the expression $t\frac{dp}{dt}$, though small, may be expressed by a similar equation. (7) If L_A, L_A', L_B, and L_B' represent similar relations of latent heats at different pressures the same for A and B, it appears probable that

$$\frac{L_A}{L_A'} = \frac{L_B}{L_B'} + c\,(T_A' - T_A)$$

(8) The ratio of the heats of vaporisation of any two bodies at the same pressure is approximately the same as that of their absolute temperatures at that pressure. The authors conjecture that this statement is also true of dissociating bodies. A large part of the experimental work consisted in obtaining the relation between vapour pressure and temperature of different substances, values of $\frac{\delta p}{t}$ had been obtained from these observations in two ways, by plotting curves with t and p as co-ordinates and drawing tangents, and by the method of differences. Prof. Perry suggested that the curve should be expressed in such a form as

$$\log.\ p = a - \frac{\beta}{t} - \frac{\gamma}{t^2}$$

which Rankine has shown to be a very true expression for the relation between pressure and temperature, and that $\frac{dp}{dt}$ should be obtained from this by differentiation.

Prof. GUTHRIE hoped the authors would experiment upon the vapour tensions of mixed liquids, a subject to which he had himself given some attention.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

17019. "Holding and supporting incandescent electric lamps." E. COX-WALKER. Dated December 30. 4d. The body of the holder may be made of wood, ebonite, or other suitable non-conducting material; two flat metal springs, bent somewhat like the shape of the letter U, are fitted or dropped into a groove in the body of the holder, and terminals attached; the loops of the lamps are placed between the tops of the legs of the U shaped springs, and two screws, which pass through the sides of the body of the holder, nip the spring tops together and hold the loops of the lamp perfectly firm and tight.

17077. "Improvements in apparatus for igniting gas by electricity." P. M. JUSTICE. (Communicated from abroad by C. W. Weiss, of America.) Dated December 31. 11d. Relates to that class of gas lighting apparatus, wherein an electric spark is produced by friction between a resinous and a metal plate, or by what is commonly known as an electrophorus.

17078. "Improvements in insulators for electrical conductors." P. M. JUSTICE. (Communicated from abroad by H. L. James, of America.) Dated December 31. 6d. Arranged longitudinally on one side of the body of the insulator, and forming a part thereof, is a raised portion consisting of ribs located opposite to each other, and having their inner edges bevelled inwardly. The line wire or an electrical conductor is placed in a slot or groove cut transversely or transversely inclined across one side of the insulator and through the ribs.

17091. "Improvements in magnetic-electric machines." H. F. JOEL. Dated December 31. 8d. The inventor constructs a dynamo-electric machine with two upright field magnets, bridged or joined across by two pole pieces, the armature revolving between them, and the whole being suitably mounted with bearings and base plates. He makes the cores of the field magnets of a laminated construction with iron plates, bars, or tubes, to prevent or neutralise as much as possible the formation of so called "Foucault," or eddy currents. He fits the plates, or bars, into solid iron pole pieces, and cuts mills, or casts slots, or grooves for the purpose in the ends of these pole pieces, into which the ends of each plate or bar, or a number of core plates or bars, side by side, are fitted, the whole being secured by bolts.

1885.

75. "Improved form of holder and switch combined for incandescent electric lamps." A. GRUNDY. Dated January 2. 6d. Relates to the apparatus already described in the REVIEW.

154. "Improvements in duplex and other systems of electric telegraphy." A. MUIRHEAD. Dated January 5. 8d. Relates to the invention described in the present number of the REVIEW.

276. "Improvements in telephonic apparatus." A. P. PRICE. Dated January 8. 4d. Relates to the use and employment as a substitute for diaphragms or other arrangements hitherto employed for telephonic purposes of an apparatus or chamber hermetically closed in which an entire or partial vacuum has been produced, and upon the surface of this apparatus or chamber the undulations or vibrations of the atmosphere due to sound are made to impinge and act upon the surface of the apparatus or chamber before mentioned, the effects of such action being communicated along the line to the receiver by the ordinary means or methods as is well understoood.

282. "Improvements in electric telegraphy and in transmitting and receiving apparatus for working long lines." A. M. CLARK. (Communicated from abroad by L. Maiche, of Paris.) Dated January 8. 8d. The inventor employs a mechanically operated transmitter, which, after each emission of a current through the line during a given time, automatically sends through the line a current in the opposite direction of proper duration, in order to restore the neutral condition of the line before the passage of another working current.

354. "Improvements in combined magnets and coils to be acted on by currents or signals in electric telegraph apparatus." J. SCOTLAND. Dated January 10. 8d. The inventor arranges the magnet or combination of magnets, which may be either electro or permanent magnets, so as to have an annular field of force in which the lines of force are in directions which are radial or in other words across the annular space. The coil which forms part of the telegraphic conductor is made in an annular form, and is supported so that when no current is passing through it, it is partly within the annular magnetic field, the lines of force of which cross its coils at right angles. With this improved arrangement a given current through the coil will produce a movement of the coil in a quicker, stronger, and more distinct manner than with ordinary arrangements, the action between the current in the coil and the magnetic forces being more completely effective, without the action of one part of the field interfering with that of another part.

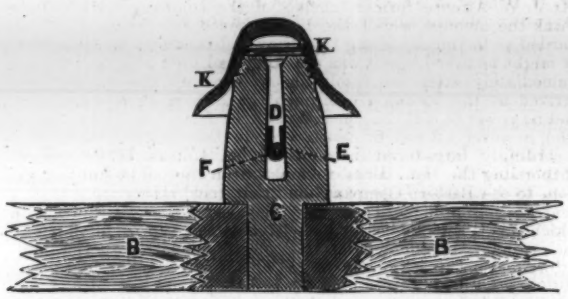
457. "Improvement in the generation or production of electricity." G. F. REDFERN. (Communicated from abroad by Messrs. Wirth and Co., of Frankfort-on-the-Main, agents for A. Bernstein.) Dated January 13. 8d. The inventor avails himself of the heat which is produced by any combustible material in order to heat a compound of hydrogen until dissociation takes place, and he then uses the products of the decomposition as electrodes of a galvanic cell.

487. "Improved method of and appliances for maintaining direct electrical communication between the shore and any vessel or floating object by means of a telegraph cable having an unbroken insulated electrical conductor, and for preventing the twisting or kinking of such cable." F. LE BRETON BEDWELL. Dated January 13. 8d. Two ends of the telegraph cable are attached to swivels or balls at the ends of a cylinder, or to one fixed end and one swivel or ball, and the insulated conductor or conductors of the cable are jointed to the ends of the insulated wire or wires contained in the case or cylinder in such a manner as to form one or more continuous electrical conductor or conductors extending the entire length of the cable, and connections from the transmitting instrument at one end to the transmitting instrument at the other end.

652. "Improvements in telephone transmitters." T. J. HANDFORD. (Communicated from abroad by E. H. Johnson, of New York.) Dated January 16. 6d. The object of the invention is more especially to produce, for the transmission of articulate speech, a practical and efficient telephone transmitter, employing electrodes of platinum or other suitable metal, at which the circuit in which the said electrodes are situated is opened and closed by the movement thereat.

1053. "Improvements relating to the application of electricity for keeping steam-boilers free from incrustation. W. R. LAKE. (Communicated from abroad by A. E. E. Jeannolle, of Calais.) Dated January 24. 6d. The shell of a boiler is placed in communication with the positive pole of the said battery by one conducting wire, whilst the negative pole of the battery communicates through another conductor with the liquid contained in the said boiler or generator.

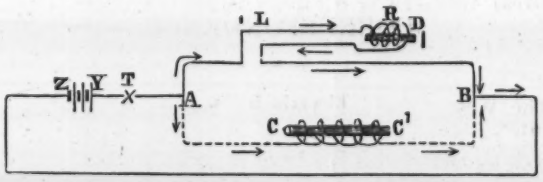
1209. "Improvements in insulators for attaching electric wires to posts." G. BARKER. (Communicated from abroad by J. W. Tringham, of Canada.) Dated January 28. 4d. B represents a cross arm for supporting the conductors, C is a common pin in which is cut a slot in a similar manner to that described in the specification of invention No. 2639 of the 2nd February, 1884, for "Improved means for supporting and insulating electrical conductors." Having cut the slot, D, the inventor then inserts a



suitable piece of insulating material, E, such, for instance, as India rubber, which encircles the wire, F. He then screws on the waterproof metal cap, K, which, it will be noticed, is tapered inside so that as it is screwed down it draws the two sides of the slot, D, together, and secures the wire, F, tightly in position. The cap, K, is made like a plug hat with a good rim to keep the rain off.

6371. "Improvements in electric arc lamps." P. JENSEN. (Communicated from abroad by V. Golitzinsky and P. O. Rymascheffsky, both of Moscow.) Dated May 23. 8d. This invention is for a new differential electric arc lamp.

6554. "Improvements in telephonic circuits." S. P. THOMPSON. Dated May 29. 4d. Has for its object to neutralise the self-inductive effects and tendency to sparking, in direct working telephonic systems, arising from the magnetism of the electromagnetic coil in the receiver, and from the self-induction of the line wire, and this is effected by compensating the circuits. In the fig. the electro-magnet in the receiver, R, constitutes with the line, L, one branch of the balanced circuit and the electro-magnet wound upon the core, C, C^1, constitutes the other branch. The electro-magnet should preferably be so wound that the ratio of its



co-efficient of self-induction to its resistance should be at least as great as, or greater than, the ratio of the co-efficient of self-induction of the line and of the coils of the receiver taken together, to the total resistance they offer. The transmitter and battery are outside the balanced circuit, the current from the battery passing through the transmitter to, A, where the balanced circuit divides. In general it is preferred that the coil of the balancing electromagnet should be wound of many turns of thick wire, so as to have a small resistance and yet a high co-efficient of self-induction. There should also be plenty of iron in the core, which should be a long one, and for this purpose need not be made up of bundles of thin wires.

6555. "Improvements in voltaic batteries." T. J. JONES. Dated May 29. 6d. Consists in constructing the supports for the active material of an inoxidisable or but slightly oxidisable substance such as India rubber, gutta percha, Xylonite, &c., or compounds containing these substances in which are embedded, or which cover or protect copper wires, strips, or other forms of conductive material in such a way that the latter is protected from oxidation, the said wires, strips, or other conductor so embedded, covered or protected, being in electrical connection with the active

material by means of gold or platinum locally applied either as a film or coating to exposed portions of the conducting wires or strips, or applied as a coating to branch wires connected to the main wire or strips and projecting through the inoxidisable support into or against the active material.

8128. "An improved switch for electric circuits." E. ZELLER. Dated July 4. 8d. Consists in forming a spring switch for temporarily opening and closing electric circuits, and more especially for use in connection with incandescence lamps, by the use of a dished plate of metal suitably secured and provided with a knob or handle, so that in one position of equilibrium it makes contact with the terminal of the circuit, and in the other position of equilibrium it breaks the circuit through it and such terminal.

8727. "Improvements in and connected with the construction and application of electric incandescent lamps." P. M. JUSTICE. (Communicated from abroad by I. W. Heysinger and J. Pusey, attorney, both of America.) Dated July 28. 8d. Relates to the construction and application of electric incandescent signs, advertising devices, &c.

8812. "Improvements in synchronous multiplex printing telegraphy. SYDNEY PITT. (Communicated from abroad by P. B. Delany, of America.) Dated July 21. 6d. Relates to the apparatus described at various times in the REVIEW.

11300. "Improvements in dynamo-electric generators." T. J. HANDFORD. (Communicated from abroad by R. H. Mather, of America.) Dated September 23. 6d. Consists in the compound winding of the field-magnet, whereby the latter becomes a differential electro-magnet.

11224. "Improvements in electric baths." M. HUMM. Dated September 22. 4d. Relates to a modification of patent No. 265, A.D. 1884, entitled Improvements in electric baths.

12170. "An improved galvanic battery." H. J. ALLISON. (Communicated from abroad by E. M. Gardner, of America.) Dated October 13. 8d. The principle of the invention is to provide a partition which shall offer the least resistance to the current while at the same time ample path for the transference of matter, and which shall be of a material not itself chemically alterable by or capable of chemically altering the fluids in which it is immersed. The inventor therefore uses a porous partition of conducting material or containing conducting material, for which purpose he finds carbon to be preferable.

12192. "Improvements in electrical railways." J. F. MCLAUGHLIN. Dated October 13. 8d. Consists of certain improvements in electrical railway systems, the main object of the invention being to provide for the running of a larger number of cars on a circuit, with the motors in multiple arc, than is possible in the ordinary way.

12193. "Improvements in electric temperature regulators." W. P. THOMPSON. (Communicated from abroad by C. A. Tucker, of New York.) Dated October 13. 8d. The object of this invention is a new and useful device for changing the air in rooms, halls, churches, and other structures, by providing a sheltered chamber open to the outer atmosphere, and a passage between it and the place in which it is desired to regulate the temperature, and means to open and close such passage automatically by the employment of an electric current.

CORRESPONDENCE.

Electric Bells.

In experimenting on the short circuit method of working electric bells, I have invariably found that it produces a very much feebler motion of the hammer than the ordinary method of making and breaking the circuit affords. As these short circuit bells are largely used with indicators in hotels and mansions, perhaps some of your practical correspondents can explain the reason, and the remedy if there be one.

J. W. J.

Birmingham, *December 18th*, 1885.

Re Electrical Formulæ.

Mr. Andersen's communication of last week must be deemed, I think, very weak. Instead of defending his term figure of merit he prefers, rather, to quibble about the wording of my last letter, and by putting a wrong interpretation upon my words to accuse me of mistakes. He also misrepresents my meaning by quoting only portions of sentences. Further, by way of beating round the argument, he quotes a train lighting episode, putting, in this instance, an interpretation upon the words which scarcely could have been the author's meaning.

It is useless for Mr. Andersen to plead that his formulæ are for use only in the construction of dynamos, since the following frequently recapitulated sentence of Mr. Andersen's proves the contrary :—"I think such a figure would be of great use to all who are working for the improvement of this comparatively new class of machinery, be it as constructors or as testers, not to speak of the interest it would have to the users of dynamos to be able to, by a single test, compare the merit of one type with that of another. Further, such controversies as have taken place occasionally in the technical journals as to the value of certain constructions—*exempli gratia* the Ball unipolar—would, if electricians had agreed upon a general figure of merit, be more likely than they are at present to terminate in a practical result."

From the preceding it is obvious that Mr. Andersen then proposed to use this particular quality of dynamos as a general criterion by which the values of machines of different types might be determined. But is it at all probable that dynamo makers will consent to have their machines valued by this one quality alone? The fact that the F $\frac{w\,a}{w\,a + w\,m}$ of a machine was large would neither ensure that it would perform work cheaply nor that it was reliable.

In his last communication Mr. Andersen says "he has shown that the annual expenses on dynamos in work, so far as they depend upon electro-magnet construction, are theoretically as the reciprocals of the coefficients of the different types of machines." But he has done nothing of the kind; because his expression F $\frac{w\,a}{w\,a + w\,m}$ would be a maximum in a machine with a small armature moving in a strong magnetic field and performing little, or no, external work; whereas several of the recent and most efficient machines rely upon a weaker field and a comparatively large armature.

I must again insist that machines of different types must perform work at the same rate while their comparative values are being determined; otherwise such absurdities will be introduced as that shown in Mr. Andersen's formula F $\frac{w\,a}{w\,a + w\,m}$ according to which by increasing the waste in the armature at the expense of the external work, $\frac{w\,a}{w\,a + w\,m}$ is increased; so that, in this case, the figure of merit is increased by making the machine less efficient and less economical.

Mr. Andersen asks the question "which are the duties or circumstances in connection with dynamos that would make a determination of the economic value of the machines useless or unimportant?" I know of none; nor have I suggested that there are any. What I have tried to impress upon Mr. Andersen is, that his letter F, or formula F $\frac{w\,a}{w\,a + w\,m}$, does not express the economic value; not that the economic value is unimportant.

To me it is evident that there is a certain proportion between the effective strength of field and the amount of conductor on the armature, which would produce the most economical result; and that either an increase or a decrease of the effective strength of the field would produce a result less economical.

The term "figure of merit" is used in telegraphy for the reciprocal of the current which will actuate a relay or produce unit deflection in a galvanometer. This term in telegraphy refers to the sensibility and not to the efficiency or economic value of the apparatus. Consequently, if the term was used as Mr. Andersen wishes, the same term would be used for two different purposes.

W. Moon.

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